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AGRICULTURAL ENGINEERING

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A Drawbar Dynamometer Adapted to Farm Implements - - - - - - - - - - - *G. W. Giles*

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The Field for Small Combined Harvester-Threshers - - - - - - - - - - - *W. M. Hurst*

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Double-Piston Pressure Regulator for Spray Pumps - - - - - - - - - - - - - *K. R. Frost*

VOL 16 NO 6

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AGRICULTURAL ENGINEERING

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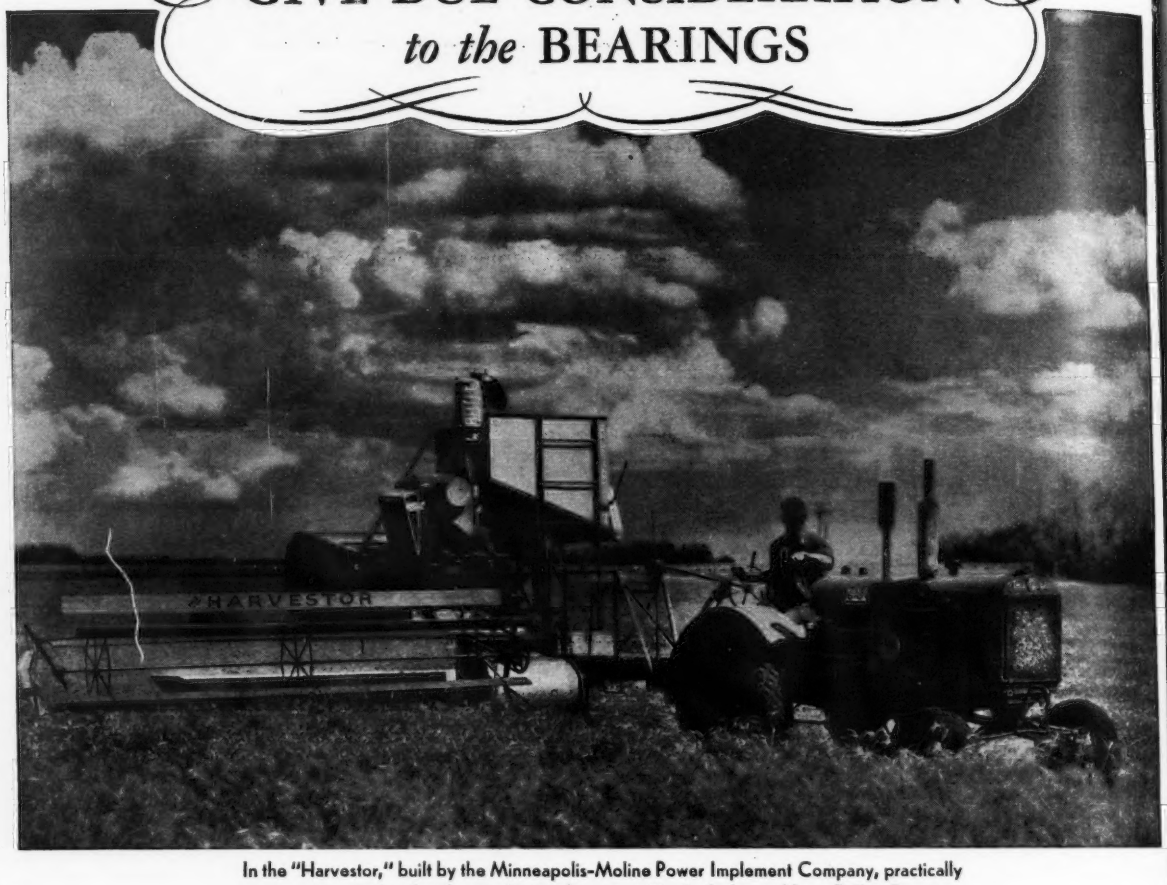

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AGRICULTURAL ENGINEERING

VOL 16, NO 6 EDITORIALS JUNE 1935

To Exchange Professors with Industry

AN ASAE MEMBER, with service so long and so successful in each field as to set up a favorable presumption for his proposal, suggests that the "exchange professor" idea be incorporated in the relations between our colleges and our industries. Naturally he contemplates a close correlation of subject matter, and has particularly in mind the departments of agricultural engineering and the manufacturers of mechanical farm equipment. In possibly lesser measures the principle seems applicable to structures and electrification.

Our profession has long been noted for a one-way traffic of this sort. Any number of ASAE members have shifted from college teaching, extension, or research into the service of related industrial units, but the change usually is permanent, with little or no compensating flow from industry to education. This one-way movement falls short of the exchange-professor plan, even in the one direction, for it means taking on a new man, rather than intensive exposure of a seasoned man to different yet complementary viewpoints and objectives. It fails to inject the commercial —some would say the practical—personality and experience into the college composite.

The exchange-professor idea implies a short period of transfer, usually a year or less, without jeopardy to rank, seniority, or compensation in the permanent connection. That is quite different from an individual "cutting loose" on his own sole initiative to achieve a somewhat similar purpose. It may be noted here that the tendency of educational institutions to evaluate men largely in terms of academic experience and alphabetical adornments is an effective check-valve against precisely the type of genius and experience they might well seek from industry. Short-term exchanges dignified by formal recognition could evade these difficulties without undue affront to hallowed tradition...

It is true of course, that a great executive or a brilliant engineer may be devoid of the instinct that makes the born teacher; or the training in pedagogy which more often takes its place. Leaving such men out of account, there are yet plenty of likely candidates for the colleges to borrow. If so desired, there are enough college-trained men in the industries, though we question the wisdom of laying down any such limitation.

The advantages, both to education and to industry, run to more detail than can be broached here. Rather it is our present purpose to propose what seems a feasible mechanism, and to invite discussion of its probable results among companies and institutions which might logically put it into practice.

Conference of Agriculture, Industry, and Science

APPARENTLY not accorded so much attention as it deserved in the general news, the meager information thus far coming to editorial attention holds promise of significant contribution to the general American weal springing from the Conference of Agriculture, Industry, and Science held at Dearborn, Michigan, on May 7 and 8. And, though not formally articulated with agricultural engineering, it seems to lend support to several principles and objectives of our profession.

The mere meeting for purposed action by outstanding leaders of the three social and economic groups is auspicious. Their resolution authorizing a committee to set up a "National Council of (representatives of) Agriculture, Industry, and Science" was offered by the president of the Chamber of Commerce of the United States (Mr. Harper Sibley, an ASAE member), seconded for agriculture by the master of the Kansas State ranges, for industry by the president of the National Manufacturers' Association, and for science by the president of the American Chemical Society. The council is proposed not as a new national society of individual members but as a coordinating forum for the three interests, presumably through existing societies and associations. In rounding out such a permanent council it seems obvious that agricultural engineers must needs be included.

Chief among the economic principles emphasized by the conference, and repeatedly set forth by sages of our profession, is the mutuality of interest, whether prosperity or its lack, between agriculture and urban industry. In a formal declaration the conference saw fit to mention the striking coincidence—if nothing more—that "with rare exceptions, for over a generation, the gross income of the farmer has been almost identical with the sum total of direct factory payrolls for labor in the city." As amplified, this aligns with the agricultural engineer's policy of promoting farm efficiency and well-being by generous use of the city's products, in contrast with a branch of agrarian thought which would have the farmer go primitive in order to escape "paying tribute" to the city.

The other major point of the conference was technical, and earned its emphasis by sound promise of restoring permanently an agricultural, and hence a general prosperity. It is the creation of industrial markets for farm products, notably by way of organic chemistry. Here again the agricultural engineer has been a voice crying in the wilderness. Though both the fundamental science and the final technology lies outside his domain, he is essential in the efficient production, preliminary processing, and incidental transportation, if the raw materials are to be of such quality and cheapness as to make them economic for industry.

Again without perceptible collusion, the conference held with many agricultural engineers that abundance and not scarcity is the route to general well-being. Apparently dismissing restrictive and regulatory policies as of only temporary, if any, benefit the conference looked to the ultimate goal of replacing lost foreign markets and reduction in per capita food consumption by a steady domestic

market for industrial ingredients. It was further set forth that the means to this end is not governmental coercion or subsidy (except only publicly-sustained research), but by private vision and enterprise.

These and related points are set forth in a "Declaration of Dependence upon the Soil and of the Right of Self-Maintenance." Fittingly enough, it follows somewhat the form and tenor of our national Declaration of Independence. The latter took on meaning only by fighting and winning the Revolutionary War. If the high purposes of the conference at Dearborn and its projected council are to flower and fruit in our national life, there must be some fighting and a bit of a revolution, technically speaking. A regiment of agricultural engineers would help.

Food Acreage Per Capita: A Variable

BETWEEN agricultural export markets, seemingly lost, and industrial markets, seemingly about to open, is the domestic food market. It usually is assumed to be controlled by the capacity of the human stomach and hence practically constant on a per capita basis. This assumption should be challenged, as indeed it has been in ASAE discussions, but not with the emphasis it deserves.

On a world basis, agricultural engineers generally agree that there never has been a food surplus in terms of human need. Findings of sociologists and nutritional experts suggest that there has been no surplus (though perhaps unbalance) of food even on a domestic basis. Whatever justified shrinkage there may in cereals is offset, or more, by nutritional needs for more of fruits, mineral-bearing vegetables, meats, and dairy products. Anemic childhood and adipose middle age are equally the results of malnutrition.

Some attempts have been made to correlate nutritional levels with acreage requirements. If memory serves, one such study showed a minimal or subsistence level, a median or ordinary level, and a high or luxury level—if we can regard being well-nourished as a luxury—to have acreage requirements, respectively, in the ratio of 1:2:3. While education in sound living plays a part, the nutritional level adopted is mainly under economic control by the family income.

If the truth be known, a goodly fraction of our people, even in so-called normal times, live at the "1" level. To bring them up to the "2" level probably would, with proper balance among crops, wipe out the surplus question. A degree of general prosperity and intelligence permitting the "3" level would call for something like a fifty per cent increase of production, divided between expanded acreage and higher yields. Surely this is a desirable objective for producer and consumer alike.

To assume the defeatist attitude that our general prosperity never can reach a point permitting the "3" level is, we believe, unduly pessimistic. Hence, agricultural engineers and land-use workers may well avoid closing the door to expansion of food-crop production, even in the face of a constant or slowly declining population. In particular, if the use of farm products as industrial raw materials reacts so favorably on the general prosperity as its proponents believe, the two effects may combine to create an acute shortage of foodstuffs.

Admittedly, such a possibility now seems remote. Yet it seems sound to think of per capita food consumption not as a constant, but as a variable which may and should be increased.

A Lesson Thrice Taught

RECORD-BREAKING DROUGHT, successive and severe dust storms without precedent, and now floods that have taken high toll of life and property —all have come within a single year to a rather definite region in the Great Plains. It looks as if Nature has concentrated her visitations to impress man—a vast demonstration, if you will—with the magnitude of her forces and to shock him into conformity with them. That this mighty demonstration has come early in a program of national emphasis on soil and water resources recalls the divine revelations which in Biblical times came to guide the people through periods of crisis. In all reverence we pray for prophets to interpret wisely the three-fold lesson of drought, dust, and flood.

The unity that runs through it all is moisture management—in the soil, in the streams, and to some extent in the atmosphere. As a nation we have been trying to cope with final symptoms—notably lower river floods—rather than to control causes. The latter, it seems to us, occur mainly at the point of precipitation and comprise the relations among runoff, percolation, storage, evaporation, and plant transpiration.

We dare not say blindly that the vagaries of weather are to blame and that nothing closer than the sun-spots has any effect. It is conceivable that radiation, evaporation, and transpiration to the west of the Rockies are so influenced by farm and forest management as to be a factor in Kansas dust storms and Louisiana floods. Certainly runoff and percolation in the upper levels of watersheds are such factors. The boundaries of Iowa and Oklahoma farms are not at the line fences, but at the Gulf of Mexico, and in a broader sense than we have known before man is his brother's keeper.

Treasured traditions of individual initiative and state sovereignty must somehow be reconciled with the grim realities of Nature's workings. It is a problem for statesmanship aided, if that be possible, by intelligent journalism. In its technical phases it is a challenge probably never equalled in the experience of our profession and that of other agricultural scientists. We must cooperate as never before with agronomy, forestry, and meteorology. In the latter, particularly, all that is known must be supplemented by more fundamental research.

In the no-man's land between national necessity and private prerogative will be the agricultural engineer. Guided largely by other scientists, it will be his job to devise and demonstrate ways and means whereby public policy will prove economic for the individual farmer.

Mechanical Equipment for Grape Leafhopper Control[1]

By O. C. French[2]

SINCE THE BEGINNING of grape culture in California, the problem of combating the grape leafhopper has been the cause of many types of equipment being developed to apply insecticides or to mechanically control the increase of this pest. This insect has been known to exist in California since 1875. The past history of the leafhopper indicates that its attacks occur in a series of fluctuations in which periods of high infestation are followed by periods of low populations. The last period of high infestation has been since 1928 to the present time, and this last outbreak has occasioned intensive work by growers, insecticide companies, experiment station workers, blacksmiths, mechanics, and others for the purpose of developing satisfactory methods of control.

The types of equipment now used for leafhopper control can be classified as follows:

1 Sprayers for applying atomized oil spray
2 Dusters
3 Ordinary orchard sprayers
4 Suction machines.

The latest development has been in the equipment for applying atomized pyrethrum oil spray. This method was not used prior to 1929 but is now probably the most widely used method of control. Accurate figures on the total amount of oil spray applied are difficult to obtain; however, an estimate of oil used in 1934 is approximately 450,000 gal.

Of the sprayers for applying oil spray there are four types: (1) compressed air sprayer; (2) blower type; (3) airplane, and (4) knapsack. The compressed air sprayer consists of an air compressor driven by a 12 or 15-hp gasoline engine. The nozzles, hand operated, are merely two jets, one for air and the other for oil. The oil is not under pressure, but flows partly because of gravity and partly because of a slightly less than atmospheric pressure created by the high velocity of the air over the oil jet. Most of these sprayers now have four nozzles and cover two rows of vine at a time. It requires five men to operate it—one man on each side of each of the two rows, and one man to drive the rig. The rate of spraying is from 2 to 3 acres per hour.

There are various types of blower vapor sprayers, but last year there were only two kinds of much importance; one of which is made by the Johnson Gear and Machine Works, at Fresno, and the other made by the John Bean Manufacturing Company, at San Jose. The Johnson machine consists of a single blower driven by a four-cylinder automobile type engine. It has two nozzles—one for each row—and the nozzles are stationary. The oil flows down to the nozzle by gravity and is broken up by a rotating cup which is driven by the blast of the air stream. The atomized oil is carried to the vines by the blast from the nozzle.

The Bean sprayer[3] differs somewhat from the Johnson sprayer in that the oil is forced out through a nozzle that is surrounded by an air blast of high velocity. The oil is partially atomized in passing through the oil nozzle and further atomized by the air blast in leaving the air-discharge nozzle. This sprayer has four blowers connected to a common driveshaft which is driven by V-belts from an engine. These blowers are driven with a 40-hp engine. This type of sprayer requires only one operator and can cover from 6 to 10 acres of vines per hour.

There are also two types of atomizing devices used by airplane spraying companies. The Independent Crop Dusting Company outfit has a wire brush driven by a small propeller suspended under each wing of the plane. Oil is forced into the hub of the wire brush and is in turn forced out along the bristles, thence thrown off the periphery of the brush.

The Hawke Crop Dusting Company use venturi tubes with screen in the discharge ends. These are mounted on a small propeller, and as the tubes are revolved, oil is thrown through the screen and out in atomized form.

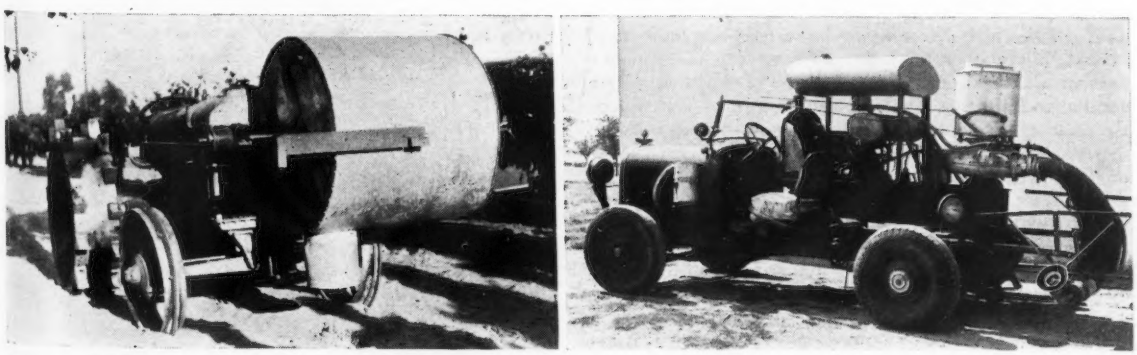
These planes ordinarily treat two rows of vines at one time, although the Independent planes have used 4-wire brush rotors and treated 4 rows at a time. They can cover from 90 to 100 acres per hour flying at the rate of 90 to 115 mph.

Knapsack sprayers, being relatively inexpensive, were

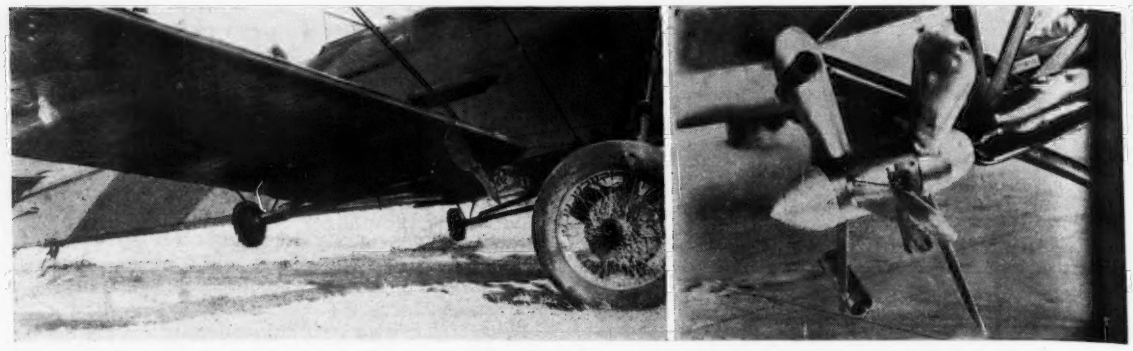
[1]Paper presented at a meeting of the Pacific Coast Section of the American Society of Agricultural Engineers, at Porterville, California, April 6, 1935.

[2]Instructor in agricultural engineering and junior agricultural engineer in the agricultural experiment station, University of California. Junior ASAE.

[3]The compressed air and Bean blower sprayers were described in the September 1934 AGRICULTURAL ENGINEERING, vol. 15, no. 9.



(Left) Air sweeper or suction type of equipment used in grape leafhopper control. (Right) Johnson blower sprayer for applying atomized oil spray



*(Left) The Independent crop duster plane, showing wire brush atomizers, used for applying atomized oil spray. (Right) A close-up of the atomizing device used on the Hawke crop dusting plane**

used during the past year. However, they are not entirely satisfactory, chiefly because of low and non-uniform pressures.

A study of the characteristics of these different types of oil atomizing sprayers has been carried on by the division of agricultural engineering of the University of California during the past three years. The contention of the originators of these different sprayers has been that the degree of atomization of the oil was an important factor in the efficiency of the application. It has been necessary, therefore, to measure the size of the oil-spray globules and attempt to correlate this information with the percentage control of the leafhopper.

The method of measuring the size of the oil-spray globules is simply coating a microscope slide with lamp black and then exposing it to the spray fog, and then use a microscope with dark field illumination to measure the oil globules collected on the slide. It was found that by measuring 300 globules at random the results were statistically reliable.

The results of such measurements show that the compressed air sprayer atomizes the oil better than any other. The average size of oil spray globules for this machine is about 30 to 40 microns under field conditions.

The Johnson sprayer atomizes the oil to about an average of 70 to 80 microns; the Bean sprayer about 85 to 95 microns. The airplanes have not been checked as carefully as the ground machines, but some tests indicate that the size of globules from them are about twice the average size of the blower type sprayers. No work has been done with the knapsack sprayers at this time.

It is logical to assume that, if the atomization is too fine, the control will be ineffective because of too rapid evaporation of the spray from the insect or from lack of penetration; also if too large a size particle is used, the vines and insects will not be as completely enveloped in the spray fog as if smaller globules were used. Such assumptions may be correct, but neither limit has yet been reached apparently because all the sprayers checked have obtained fairly good results, and also the percentage of control by each is about the same, *if* the application has been carefully applied.

A study of the blower vapor sprayer showed that much of the power of the engine was being consumed in creating a high velocity air blast to atomize the oil. This is particularly so with the Bean sprayer. The Johnson sprayer also requires a large part of the air blast just to turn the atomizing cup. It seems reasonable if atomization can be obtained by means of a small pump and nozzle and then have a large volume air stream at less velocity to carry the atomized oil to the vines, that considerably less horsepower would be required. Also if a larger volume of air at less velocity were used, better penetration could be obtained. It also seems desirable to run a fan at less speed than the present speeds of from 4000 to 5000 rpm.

Some experiments were made with the cooperation of the John Bean Manufacturing Company this past winter to determine whether this idea was practical. To make a comparison of the distance two volumes of air streams would carry, the following set-up was used:

A 10-in discharge duct with a flow of 3200 cfm at a velocity of 6320 fpm and an air horsepower of 1.26; and a 5-in duct with a flow of 1250 cfm at a velocity of 10,150 fpm and also an air horsepower of 1.26. A comparison of these two air streams was made by placing a Monarch atomizing nozzle in the end of each discharge duct and atomizing regular leafhopper spray oil into the air stream.

It was easily apparent that a better spread of spray fog was obtained with the larger volume of air, and also it carried considerably farther. Measurements of the oil globule sizes showed that excellent atomization was obtained.

The significance of these tests is that by proper selection of a blower to give a relatively large volume air stream at lower velocity than used at present, the horsepower required can be reduced considerably and also the maintenance and danger of the blower unit reduced.

The problems that would arise upon application of this method are:

1 Proper nozzle selection and position of oil nozzle
2 Filtering of oil
3 Whether round air discharge can be used
4 Number and positions of air nozzles for proper air distribution.

A comparison of these different types of oil atomizing sprayers by listing their advantages and disadvantages might be helpful.

COMPRESSED AIR SPRAYER

Advantages:

1 Creates a dense spray fog
2 If properly handled, excellent coverage can be obtained
3 First cost relatively low.

Disadvantages:

1 Hand-operated nozzles are not foolproof (Human element)
2 Requires several men to operate
3 Slow.

BLOWER-TYPE SPRAYER

Advantages:

1 Covers acreage quickly
2 Requires only one operator as nozzles are stationary.

(Continued on page 217)

*The author is indebted to Mr. Frank B. Herbert of the Balfour-Guthrie Company for the pictures of the airplane atomizers.

A Drawbar Dynamometer[1]

By G. Wallace Giles[2]

WITH the introduction of a research project in soil tillage at the University of Missouri, a drawbar dynamometer was designed and built. In its development the following requirements were considered essential and were adhered to in the main:

1 It must be adaptable to all farm implements, either horse or tractor-drawn, and thus have a load range up to 3000 lb
2 It must be relatively short coupled
3 It must be of the recording type
4 It must be light, rugged, and simple to use.

A thorough study was made of various dynamometers, the good points were selected, and an effort was made to incorporate them into one instrument that would satisfy the above requirements.

The dynamometer developed consists of three major parts: (1) the hydraulic unit, (2) pressure recording instrument, and (3) oil transmission line. Fig. 1 shows the complete dynamometer.

Hydraulic Unit. To meet a wide variation in loads and to secure a trace well away from zero on the chart, three cylinders and pistons were designed and built. These are shown in Fig. 2 and have diameters of 1.040 in, 1.907, and 3.300 in, and capacities of 300, 1,000, and 3,000 lb draft, respectively. Their weights, including the clevis for the power source, are 3, 13.5, and 25 lb. A working drawing of the medium-sized cylinder and piston of 1000 lb capacity is shown in Fig. 3.

Fig. 4 is a working drawing of the small cylinder and piston of 300 lb capacity. The large unit is built similar to the medium-sized unit, except heavier, to stand larger loads. It will be noticed that the units are designed for direct pull. The extension of the hitch to accommodate the unit, however, is very small. The maximum lengths of the large and medium-sized units, including the clevis hitch for the power source, are 12 in. If the universal attachment for the implement hitch is not used, the length is only 10¾ in. The length of the small unit is 5½ in. The small extension of the hitch between the power source and the implement is not objectionable and an advantage is gained by doing away with any lever system. By the use of three cylinders the weight of the unit, as compared to the pull, is kept within reason. Further, the small cylinder and piston are well adapted to experimental work in miniature models in the laboratory.

It will be noticed that a rubber washer is used on the piston. This works very satisfactorily. A light engine oil diluted with about one-third kerosene gave no leakage. The light fluid gives a trace with no time lag. Throttling, to get a smoothing out of the trace to any desired degree, is secured by a small needle valve located in the oil line and mounted on the instrument frame.

Pressure Recording Instrument. A 12-in recorder, manufactured by the Foxboro Company, Foxboro, Massachusetts, is used. It takes a round chart which is considered superior to the strip chart because of its ease in handling in the field and in filing. The case is dust proof and made of aluminum. The glass front permits inspection of the chart during the test. It is equipped with a bronze helical spring movement calibrated for pressure of 0 to 350 lb per sq in, and protected for overloading. The pen is a special reservoir type to prevent spattering where fluctuations may be wide and rapid. A second pen, operating on the same time arc, marks on the periphery of the chart. It is actuated by an electro-magnet operated by a 1½-volt flashlight battery mounted on the instrument frame. With the use of a push-button switch on the end of an electric cord, and carried by the operator, the start and stop of a test may be indicated.

The recorder was purchased with two interchangeable clocks, one of a 30-min rotation and the other of a 15-min rotation. However, in securing soil-resistance maps it is desirable to secure a longer trace for a given distance traveled than the 15-min rotation will give. A clock with a 7½-min rotation could not be purchased, therefore, a 15-min clock was rebuilt. It was necessary to add an additional mainspring to secure sufficient power. The clocks may be started and stopped at will by a small lever mounted on the outside of the case.

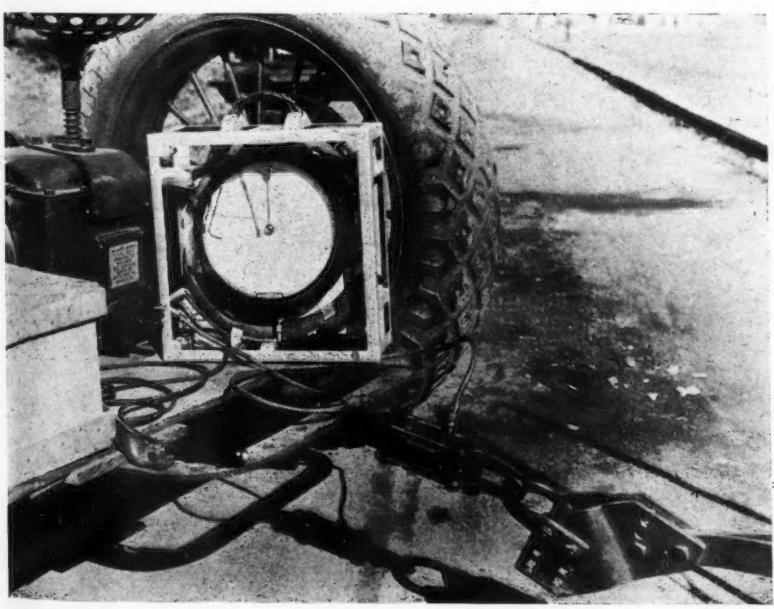


Fig. 1 The dynamometer developed by agricultural engineers at the University of Missouri attached to a tractor plow

[1]A contribution from the Department of Agricultural Engineering, Missouri Agricultural Experiment Station, Journal Series No. 400.

[2]Research assistant in agricultural engineering, University of Missouri.

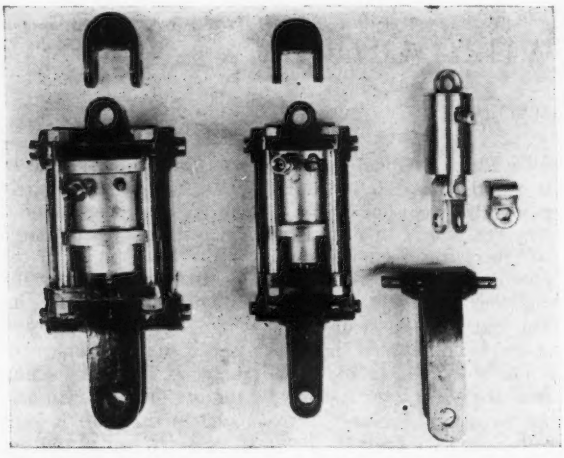


Fig. 2 Hydraulic units with capacity of 500, 1,000, and 3,000 lb draft

Either of two kinds of charts are used. One chart graduated from 0 to 1,000 lb is used with the medium-sized cylinder. The other chart graduated from 0 to 3000 lb, when used with the large cylinder, reads pounds of pull direct, and when used with the small cylinder reads ten times actual draft.

Pneumatic Mounting for Instrument. The reader is perhaps aware that a recording instrument of this type is very delicate and not designed for the rough use that may be encountered in field work. The first method of attack of this problem was to mount the recorder on springs in a wooden box. This was unsatisfactory in adequately protecting the instrument from mechanical shock and also from the standpoint of weight. The final solution, which proved entirely satisfactory, was to cushion the instrument by mounting it between two 15-in lengths cut from a 30-in by 3-in rubber tube and vulcanized at the ends. The tubes are inflated to a very low pressure, the lower mounting carrying slightly more pressure than the upper. A diagrammatic view of this mounting is shown in Fig. 5. The tubes are held between the recorder and the frame by retainers made from one-inch strips of sheet iron and rounded to fit the tube. These retaining arcs are so spaced and limited in number that sufficient room is allowed for tube expansion and no metallic contact occurs between the recorder and the frame. The recorder is mounted with the top tilted back approximately ten degrees from the vertical so as to insure a good contact between the pen and the chart at all times. The framework is constructed from one-inch angles made from 18-gauge galvanized sheet iron. The total weight of the framework and recorder is 22 lb. The recorder may be conveniently carried along during the test run, or it may be strapped to the implement or tractor in any convenient place.

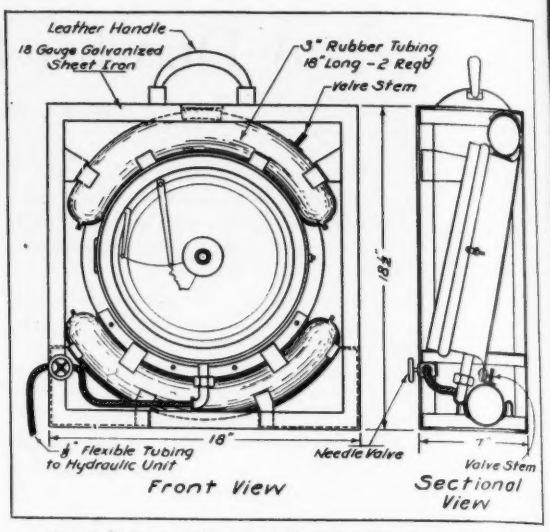


Fig. 5 Diagrammatic view of the pneumatic mounted recorder

The effectiveness of the mounting in protecting the recorder for mechanical shock was determined by placing the dynamometer with cylinder and piston clamped for a constant pressure on a tractor equipped with 5-in spade lugs and driven at 3¼ miles per hour over a hard-surfaced road. This severe condition will never be met in the field. As a comparison, a similar record was secured with the recorder mounted on springs. Fig. 6 shows a photographic reproduction of the records secured.

The oil-pressure transmission line is a ⅛-in flexible all-metal tubing, manufactured by the Titeflex Hose Company, Newark, New Jersey, and will stand pressure well in excess of 350 lb per sq in.

Calibration. The entire dynamometer system for the two larger cylinders was calibrated for accuracy with the use of an Olsen testing machine of 5,000 lb capacity. Direct loading by use of known weights was used in calibrating the instrument with the small cylinder. The resulting

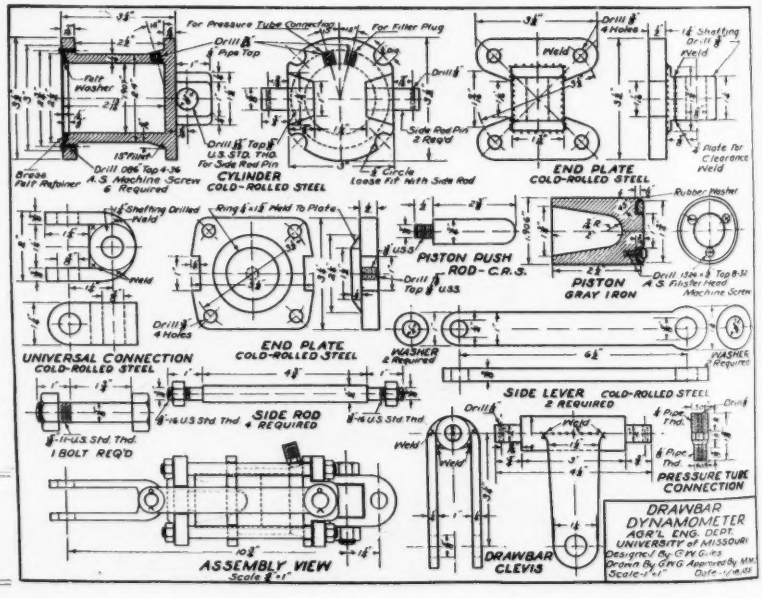


Fig. 3 Working drawing of the medium-sized hydraulic unit with capacity of 1,000 lb draft

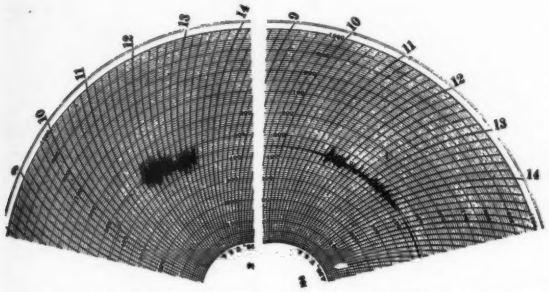


Fig. 6 (Left) Record secured with recorder spring mounted and hydraulic unit clamped for constant pressure, and placed on a tractor equipped with 5-in spade lugs and driven at 3¼ mph over a hard-surfaced road. (Right) Record secured under same condition as left except recorder was pneumatic mounted

curves, prepared by taking small load increments, showed that at all points the indicated load values needed no correction.

Determination of Average Draft. The average draft of a record may be secured by the use of a planimeter. However, experience indicates that the following method will give results which, for all practical purposes, are just as accurate as the planimeter method. Average values are read from the chart for equal intervals, such as ten seconds, during the length of the trace and these values are in turn averaged. This is a much simpler and quicker method and does not require the purchase of a special planimeter for circular charts.

CONCLUSION

This dynamometer has satisfactorily undergone a series of extensive trials, conducted throughout the spring and summer of 1934, in connection with the soil tillage studies. The spring mounting for the recorder was used at that time, but a few special trials since with the use of the pneumatic mounting, prove this a great improvement. The dynamometer is easy and quick to adapt to any farm implement. The small cylinder is particularly adapted to the measurement of the draft of one horse, as on a one-row cultivator, where it would be necessary to rearrange the hitching system in order to secure a record of the total draft. The hydraulic units are simple to construct. All the work may be done in any shop equipped with a good lathe for a cost slightly in excess of the labor.

Mechanical Equipment for Grape Leathopper Control

(Continued from page 214)

Disadvantages:

1 First cost high
2 Coverage liable to be poor because of stationary nozzles
3 Operating costs are higher.

AIRPLANE SPRAYERS

Advantages:

1 Fast method.

Disadvantages:

1 Application limited because of wind conditions
2 Application much more liable to be ineffective than ground machine.

KNAPSACK SPRAYER

Advantages:

1 Inexpensive
2 Adaptable to small acreages.

Disadvantages:

1 Slow
2 Non-uniform pressure
3 Spray fog probably not cover large enough area.

Regardless of what sprayer is used it is necessary that care be exercised in getting adequate coverage. Timeliness and thoroughness go hand in hand with this type of pest control. Experiments have shown that, if an oil spray is applied in the spring before many eggs are laid, a good clean-up will be obtained. If the overwintering adults are killed before they lay their eggs, usually the control will last throughout the summer. As the season progresses, the foliage gets heavier, and by the last of May it becomes difficult to get good control. It also costs more money to apply oil at this time of year because it takes about twice the quantity. It requires about 2½ to 3 gal of oil spray per acre for the treatment of overwintering adults. For the treatment of the first brood nymphs it may require from 5 to 6 gal per acre for thorough coverage.

The use of the ordinary orchard sprayer for the control of the leafhopper is limited for several reasons, largely because it is too slow and the liquid sprays are only effective against nymphs.

Dusting machines are used a great deal in combating the leafhopper. It is obvious that dusts cannot be used in wind or even light breezes, because the dust cloud cannot be confined to the vines. If dust can be used, then the power duster is the best equipment to use. The dusters now available can apply the dust into the vines very well and can cover acreages very rapidly. The greatest fault of

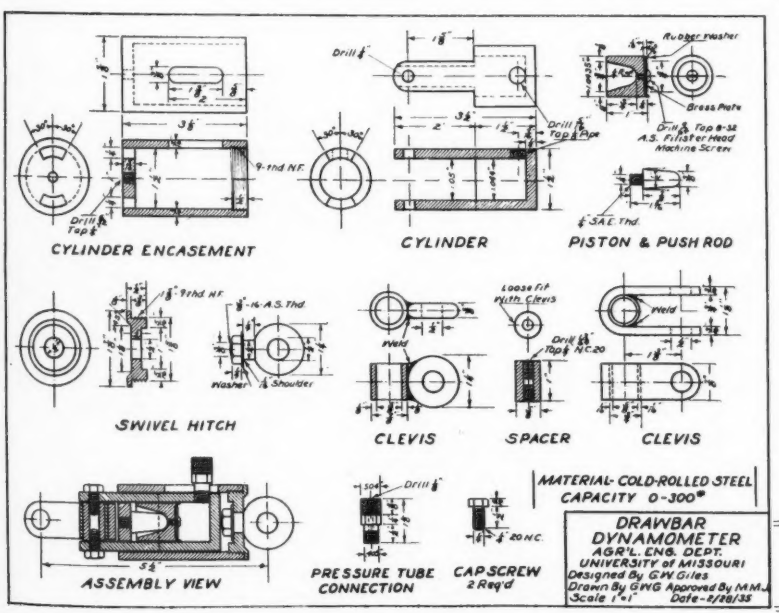


Fig. 4 Working drawing of the small hydraulic unit of 300 lb capacity

most dusters is the nonuniform and inaccurate means of controlling the flow of dust into the air stream. Some regulating device must be developed before these will be most effective.

The use of the air sweeper or suction machine has been tried for many years, and in 1931 there was a revival of this method. The most effective types have aided in the reduction of adult leafhopper populations. To really keep down the population the use of the machine must begin as soon as the overwintering adults move to the vines and then continue its use throughout the summer. The control by this method has not been nearly as successful as either oil spray or dusts and there are relatively few such machines in the grape-growing areas.

A Simple Device for Precooling Milk

By C. I. Gunness[1]

WHEN electric refrigeration is used on the farm to cool milk for the wholesale market, it is customary to place 20 or 40-qt cans of warm milk in a cold-water bath cooled by the refrigeration machine. This puts the full refrigeration load of reducing the temperature of the milk from 95 deg to 45 deg on the machine.

In a few cases, farmers precool the milk before it is placed in the cooling tank. In practically all cases where milk is cooled over an aerator, the upper sections of the aerator are cooled by running water, and the lower sections are cooled by refrigerated water or brine. In many states farmers supplying milk to the wholesale market are discouraged from using aerators due to the difficulty of keeping them clean. The following plan is suggested in order to get the benefits to be obtained from an aerator without actually using one.

Fig. 1 shows two milk cans placed on a platform in the milk room where the milk is strained. The platform is provided with a curb and drain. Running water is sprayed on to the cans through five 1/8-in holes spaced 2 in apart in each of the 1/2-inch pipes. The pipes are 13 in long, and spaced 8 1/2 in for 20-qt cans and 10 in for 40-qt cans. The results which can be obtained with this system of precooling are indicated in the accompanying table.

It is apparent from the accompanying table that it is possible to cool the milk to 70 deg for most of the year. Water is usually available at from 50 to 55 deg even in hot weather, and during a large part of the year at 50 deg or less.

Precooling milk as suggested not only reduces the load on the refrigeration unit, but it also provides much more rapid cooling of the milk. Fig. 2 gives the rate of cooling when milk at 95 deg is placed directly in the cooling tank, and also when the milk has been precooled to 70 deg. It will be seen that, whereas it requires two hours to cool from 95 deg to 50 deg, it takes only one hour to cool from 70 deg to 50 deg. While the temperature of the water in the tank rose from 37 deg to 50 deg in the first case, it rose to only 42 deg when cooling precooled milk.

PRECOOLING MILK FROM 95 DEG

20-qt cans cooled 20 min			40-qt cans cooled 30 min		
Cooling water		Final milk	Cooling water		Final milk
Temp., deg	Gal/can	temp., deg	Temp., deg	Gal/can	temp., deg
43	20	69	44	30	69
43	35	64	44	65	61
50	20	70	50	35	70
50	35	65	50	60	66
60	20	78	60	40	74
60	35	74	60	60	72

[1]Professor of agricultural engineering, Massachusetts State College. Charter Mem. ASAE.

Fig. 1 A simple arrangement for precooling milk

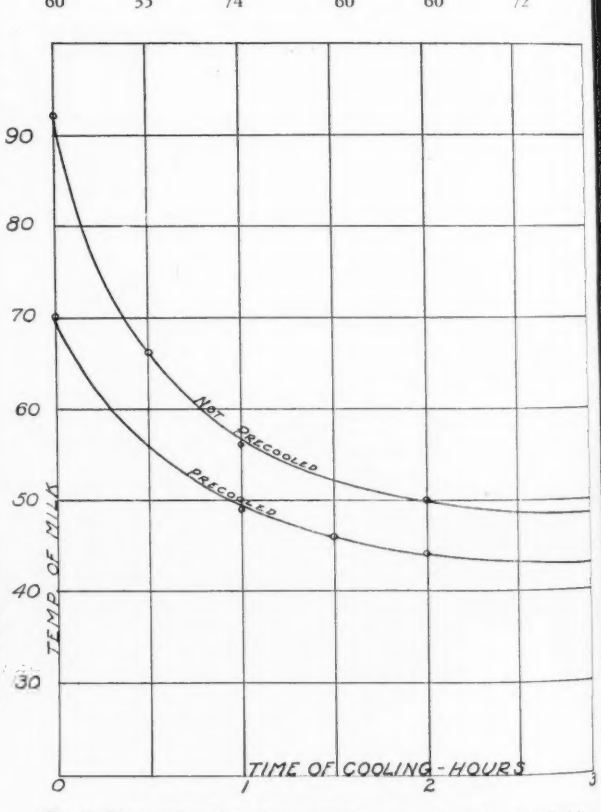


Fig. 2 These curves show the comparative rates of cooling milk that is precooled and not precooled

The Farm Tillage Machinery Laboratory

By John W. Randolph[1] and I. F. Reed[2]

TILLAGE TOOLS and practices have been developed largely by empirical methods. Within the last few years much has been learned about physical characteristics and dynamic properties of soils that affect their tillage behavior. Since some of the factors that affect soil tillage have been recognized but never tested with full-sized field tillage tools under rigidly controlled conditions, a real need has developed for a laboratory that would meet these requirements. Temporary and semi-permanent effects are produced on soils by variously designed tools, but no opportunity has existed to measure the forces required to produce these effects.

The need for such a laboratory has been made evident by the fact that the results of different field studies with tillage machinery have not always been in agreement, and have not produced a basic scientific understanding of the dynamic relationships involved in obtaining economically the best soil conditions for plants. The studies made have been spasmodic and isolated because of the inaccessability at one location of different soils varying systematically in physical and chemical characteristics, and have been delayed due to the forced dependency upon nature to produce comparable or desired soil conditions. A great difficulty in measuring the exact relationship between tillage-machine design and soil factors has been the lack of uniformity of the surface soil in the test fields.

To overcome some of these difficulties, the farm tillage machinery laboratory of the USDA Bureau of Agricultural Engineering has been established at Auburn, Alabama, on a site furnished to the federal government by the Alabama Agricultural Experiment Station under a 99-year lease. The funds were provided by the Public Works Administration.

General Plan of the Laboratory. The farm tillage machinery laboratory comprises 11 bins of soil for making the tests, and an office, shop, and storage building. There are seven bins 20 by 250 ft and four bins 20 by 125 ft, each 2 ft deep (Fig. 1). The bins are separated by reinforced concrete walls 14 in thick, which extend 10 ft beyond the ends of the bins. A 10-by-20-ft space at one end of each bin is floored with concrete for an apron on which to assemble test equipment. On the dividing walls are mounted 8-by-10-in H-beam rails on which the testing machines and soil-conditioning equipment will run. The only tool that will touch the soil will be the one that is actually being tested. The tread for the power car, dolly car, cover cars, etc., is 21 ft and 2 in, in order to straddle the plots.

The walls of the bins have been waterproofed with pitch, and the bottoms covered with tar cement and a tarred fabric water-seal that will not crack with slight settling. Each half length of the bin bottom has a fall of 2 in southward to a drain outlet, drainage across the midlength line being prevented by a rise of 2 in in the waterproof bottom. Drainage is provided under the soil by inverted V troughs made of worm-eaten cypress. Tile lines lead from the plot drains to a header tile line, except for one plot from which the drainage water is led into a basin for measurement. Tile lines through the plot walls are provided to carry away the surface run-off and that from the cover cars.

The building (Fig. 2) is fireproof. The office section is 20 by 40 ft in plan, two stories high with a basement. In it are two offices, soils laboratory, drafting room, storage vault, storage and locker room, and boiler room. The shop and machinery storage section is 35 by 85 ft, one story and basement, the latter opening at ground level on the low side of the building. The storage floor is at the same elevation as the soil-bin walls, and on this floor are provided 8-by-10-in H-beam rails, spaced as on the plot walls, for the plot-working and test equipment. This equipment is rolled onto the dolly car for transfer between this room and any plot. A 2-ton overhead traveling crane in this room facilitates handling the machinery, and hatches in the floor make it easy to transfer equipment to the shop which is in the basement. This lower floor includes also a garage large enough for storing a truck and a car, and has bins in which to keep small parts for cotton planters, cultivators, and other machines.

Contracts have been let for the construction of a special power car, or tractor car, and a dynamometer. The power car with its 135-hp engine will be mounted on eight 34-by-

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[2]Assistant agricultural engineer, Bureau of Agricultural Engineering, U. S. Department of Agriculture. Junior ASAE.

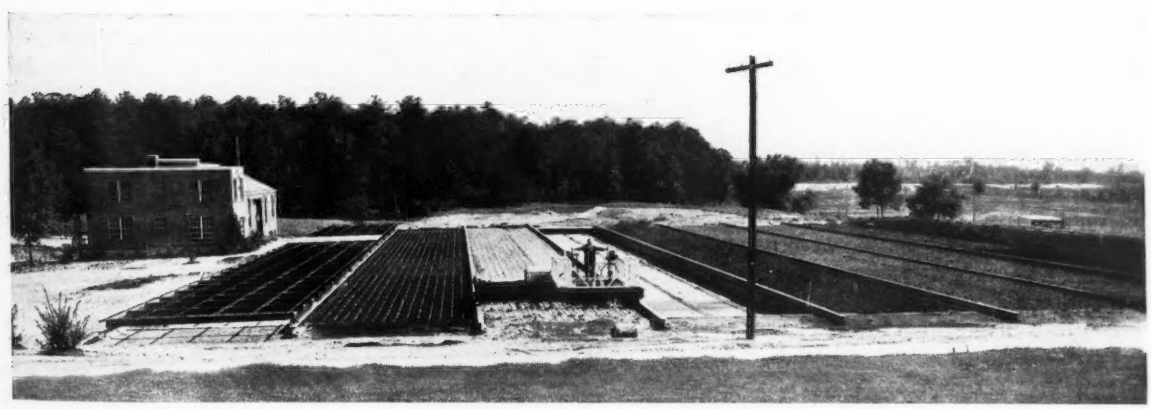

Fig. 1 Soil bins and office and storage building of the farm tillage machinery laboratory of the USDA Bureau of Agricultural Engineering at Auburn, Alabama. On the bin at its left are cover cars, still lacking themetal cover sheets. On the third bin is the powered dirt car, used in filling in the bins; the fourth bin, empty, shows the wooden underdrains

Fig. 2 Office, storage, and shop building (basement side) of the USDA farm tillage machinery laboratory

7-in pneumatic tires; the complete car will weigh about 9 tons. It will have a speed variation from 0.2 to 10 mph, (miles per hour) will be able to attain a speed of 6 mph in 3 seconds with a drawbar load of 5,000 lb, and will accelerate a load of 3,500 lb to 8 mph in 4 seconds. The dynamometer will be mounted at the drawbar heads of the power car, and will measure the three directional force components of draft.

The basis of the soil-fitting unit is a grader circle and lift mechanism, mounted on a superframe that can be moved crosswise of a plot within a car frame. The car has a 14-ft wheelbase, and straddles a plot. This by manipulation of the lift mechanism, fitting equipment can be set at any desired level relative to the plot rails. A grader blade and special roller which mount on this circle provide for leveling and packing the soil. Other soil-fitting tools can be mounted on this circle. This equipment will make it possible to produce any desired soil compaction or density, and to level the soil surface in a bin to a definite base relative to the rail surfaces on which all test equipment will be operated.

Twenty cover cars have been constructed, each 26 ft long and the width of one plot. Each consists of a steel frame mounted on flanged wheels and covered with 20-gage, 1¼-in, corrugated galvanized roofing. The cars are arranged with the roofs all sloping in one direction. Gutters along the lower edge conduct the run-off water to funnels in the tile lines through the plot walls. These twenty cars are enough to completely cover two plots, and may be used on any plots or parts of plots as desired to maintain or produce a necessary soil condition.

A dolly car has been constructed for transferring the machinery from plot to plot and for carrying it to the storage and shop room.

The Soils in the Bins. The soils in the bins were selected by Dr. George D. Scarseth of the Alabama Agricultural Experiment Station. The soils were selected with the objective of obtaining as broad a variation as possible in soil characteristics that affect the physical properties and tillage behavior of soils. The selection was based on a systematic consideration of the chief factors that cause variation in physical properties of soils. These factors for the soils of the humid southeastern United States are, in general, (1) the colloid content or soil texture; (2) the nature of the colloid fraction, or the chemical composition of the colloid as reflected in the silica-sesquioxide ratio (a low ratio indicating a highly weathered and mature soil with a friable clay fraction, and a high ratio indicating an immature soil with a plastic clay fraction); (3) the degree of calcium saturation or acidity, and the calcium carbonate content; (4) the organic matter content.

The 11 soils are representative types from the southeastern states. They comprise (1) Norfolk sand, (2) Davidson fine sandy loam, (3) Davidson clay, (4) Cecil clay, (5) Sharkey "delta" silt, (6) Sharkey "buckshot" clay, (7) Oktibbeha clay, (8) Eutaw clay, (9) Lufkin clay, (10) Houston clay, and (11) Decatur clay loam. Soils 1 to 4 of these have a low silica-sesquioxide ratio of the colloidal fraction, approximating 1.3, and colloid contents ranging from 9 to 67 per cent. Soils 5 to 10 have a high silica-sesquioxide ratio, in the neighborhood of 3.0, with colloid contents from 30 to 74 per cent. The Decatur clay loam is intermediate in both silica-sesquioxide ratio and colloid content.

Soils 1 to 4 are mature in respect to weathering. They are acid with a low content of organic matter, varying chiefly in colloid content (clay content) with all other important factors constant. Soils 5, 6, and 9 vary chiefly in colloid content, with the other factors constant, and represent immature soils of the region. Soils 4, 7, and 8 are heavy clays similar in all respects, except the chemical nature of the colloid; their range of 1.2 to 3.8 in silica-sesquioxide ratio comprises almost the extremes for southeastern soils. Soils 6, 8, and 10 are heavy clays with similar silica-sesquioxide ratio (degree of maturity), but soil 8 is very acid, soil 6 is nearly neutral and without any free carbonates, and soil 10 is alkaline with free carbonates present.

Soil 3 is a "push" soil, that is, it does not scour well in plowing, the adhesion of the soil to the metal seeming to be greater than the cohesion of the soil particles. Soil 6 is the "buckshot" soil of the Mississippi Delta, with which several difficult tillage problems are associated. Soil 9, the Lufkin clay, is extreme in all physical properties.

Range of Studies Contemplated. The implements to be tested at the tillage machinery laboratory will comprise plows, harrows, drags, rollers, cultivators, and other items of soil-working equipment. Determinations will be undertaken relating to (1) the effects of different tools and implements upon the tilth and the soil structure; (2) the minimum amount of soil manipulation that will produce the maximum or a satisfactory tilth; (3) the power requirements of different types of equipment; (4) the effects of variations in design, in working depth, and in speed of operation upon the power requirements; (5) the directional components of the draft for different designs and adjustments of the tillage implements; (6) the effects of soil-type characteristics and of the physical condition of the soil upon the power requirements and upon the amount of soil manipulation necessary to obtain good tilth; and (7) the resistance of different metals to scour in sticky soils and to wear by hard soils. The facts ascertained will find application in improvement of farming practices for effectiveness and economy, and in the design and construction of tillage machinery.

The Field for the Small Combined Harvester-Thresher[1]

By W. M. Hurs.[2]

FEW, IF ANY, agricultural implements have received as much publicity as the combined harvester-thresher. The history of this machine and its economic importance are known to practically all persons interested in agriculture. However, a brief review of some of the elements involved in its use may be of interest in pointing out the need for future development.

The development and widespread use of the "combine" was retarded for over 75 years because farmers, grain dealers, and farm machinery manufacturers thought it would work successfully only on the Pacific Coast. After the practicability of the combine had been demonstrated in the great plains states, it was predicted that its use would be restricted to areas where large-scale farming was practiced in dry areas. The demand for combines for harvesting soybeans in the corn belt, the introduction of the one-man combine, and the windrow harvester again made possible a wider use of this type of equipment.

However, at the present time, with approximately 60,000 combines on farms in the United States, no further extensive use of the combine is likely unless changes are made in the design of this machine. A combine with capacity for a large volume of straw or vines suitable for use with the general-purpose tractors will, it is thought, greatly extend both the area and number of crops for which the use of such a machine will be practicable. In addition to widening the field of usefulness of the combine, there may be a considerable demand for this machine to replace binders and threshers in the corn belt as they become worn out. There has probably never been a time in recent years when as many wornout binders and threshers have been in use as now.

Small combines with moving parts driven from the power take-off of the tractor have not been entirely satisfactory when operated by a tractor which depended upon action from the clutch shaft for rotation of the power take-off. With such tractors, quick and skillful shifting of gears is required to prevent the moving parts of the machine from stopping when the clutch of the tractor is disengaged. When the combine becomes overloaded and it is necessary to stop, the machine clogs during the process of stopping the forward motion of the tractor. A review of tractor patents indicates that manufacturers are giving a great deal of attention to tractor-operated machines in overcoming many of the difficulties formerly encountered in operating this type of equipment.

Few, if any, agricultural machines are more efficient in performing the work for which they are intended than combines. However, the cutter bar is designed for heading ripe, dry grain and the cylinder for threshing such material. In harvesting soybeans in the South, it is necessary to cut the plants within two or three inches of the ground and to handle a large volume of tangled vines and green weeds. In combining rice in the South, it is also necessary for the machine to handle not only green (unmatured) straw and weeds, but also much more straw than is customary in harvesting wheat.

The combine is also one of the few machines which may be purchased as well as operated at a lower cost than the equipment which it replaces. It is not, however, sufficiently low in first cost to permit of its use on thousands of farms where general-purpose tractors are used. A small inexpensive combine of somewhat different design than those now on the market would, it is believed, be used on many small farms in the east north central, middle Atlantic, and some of the south Atlantic states for small grain; in the south Atlantic and east south central states for soybeans, alfalfa, and clover, as well as a stationary thresher for cowpeas and other legumes.

In the middle Atlantic states (New York and Pennsylvania) approximately 59 per cent of all farms are under 100 acres in size, with 55.7 per cent ranging in size from 50 to 174 acres. The west north central group (Illinois, Indiana, Ohio, Michigan, and Wisconsin) have approximately 53 per cent under 100 acres, with 61 per cent ranging in size from 50 to 174 acres. In the south Atlantic states (Delaware, Maryland, Virginia, West Virginia, North Carolina, South Carolina, Georgia, and Florida), and in the east south central group (Kentucky, Tennessee, Mississippi, and Alabama), the average size of farms is smaller than in the other areas mentioned. In the south Atlantic states, 75.7 per cent are under 100 acres and 57.5 per cent range in size from 20 to 99 acres. In the east south central group, 79.7 per cent are under 100 acres and 58 per cent range in size from 20 to 99 acres.

In the middle Atlantic, south Atlantic, east north central states, and throughout the corn belt, combines will perform satisfactorily in harvesting small grain and soybeans, but the acreage is too small on individual farms to justify the purchase of such an expensive

[1]Paper presented at a meeting of the Power and Machinery Division of the American Society of Agricultural Engineers at Chicago, December 3 and 4, 1934.

[2]Associate agricultural engineer, Bureau of Agricultural Engineering, U. S. Department of Agriculture. Assoc. Mem. ASAE.

machine. In the east south central states, especially in the Mississippi River delta region, the combine will not work satisfactorily in harvesting soybeans due in part to the large volume of vines which must be handled.

For the wider use in states east of the Mississippi River, the following features appear to be desirable and in some cases essential for a small combine:

1 Cut a 5 or 6-ft swath

2 Threshing cylinder designed for large mass of straw and vines; possible width of cylinder same as width of cutter bar

3 Cutter bar adjustable to cut within 2 in of the ground

4 Reel of such design as to gently pull crop back on elevator without shattering

5 Overall width of machine not more than 12 ft, or of such design that not more than 15 to 20 min are required in getting machine in condition for transporting from one field to another

6 Weight from 2,500 to 3,000 lb

7 A maximum cost to farmers of $500

8 Suitable for small grain, soybeans, and other legumes

9 Driven by power take-off from tractor

10 Possessing means for quickly adjusting concaves and reel—preferably from driver's or operator's platform

11 Flexible mounting — pneumatic rubber tires or springs

Discussion by Martin Ronning[3]

IN THE VARIOUS sections of the United States and Canada where combines have come into general use, the conception of what constitutes a small combine will be found to vary according to territories.

For example, the pioneers of combine harvesting in the wheat country of Washington and Oregon, for the most part, still purchase the largest machines available. The large combine also continues to be popular in California. The farmers there feel that the large machines are better suited to handle the exceedingly rank growth of grain with which they must contend on irrigated land.

At the time of the introduction of the combine into the wheat-growing regions of the great plains, large tractors were in general use and naturally fairly large combines were purchased as a result. In late years, however, owing to the increasing popularity of the two and three-plow and the all-purpose tractors, the trend here has been definitely toward smaller combines. Due to the large acreage to be covered in the great plains area, it is very doubtful whether a combine with less than a 12-ft cutter bar will gain great popularity in that section.

For the past few years much thought has been given to the corn belt as a potential combine territory. The steadily increasing soybean acreage has given impetus to the use of the combine in some sections of the corn belt. In this area of relatively small farms the large combine with a 16 or 20-ft cutter bar is not as a rule practical.

The question of the ideal size combine for this territory has been the subject of much controversy. Most farmers who might be considered prospective buyers already have tractors and have been cutting their grain with 8 or 10-ft power binders, and it does not seem logical that they would favor a combine with a shorter cutter bar. On the contrary, it would seem that it would be desirable to have a combine of sufficient size and capacity to cover a given acreage in a shorter time than required with a binder, as the risk of letting the grain stand until ripe for combine harvesting would be greater than it would be when ready for harvesting with a binder. Of course, when a windrower is used in connection with the small combine, some of the elements of risk can be eliminated, but the windrowing method also has its disadvantages to the farmer in that it entails the extra investment in a windrower and the added cost of harvesting. There is also the possibility of adverse weather conditions resulting in damage to grain in the windrows.

A combine to be successful in the diversified farming areas of the corn belt and also in the eastern states must be able to handle tall coarse weeds without difficulty. It is an inescapable fact that whether the combine has a 20-ft cutter bar or a relatively short cutter bar, the threshing and separating mechanism in each case will be called upon to handle the same type of rank-growing crops and tall weeds.

For this reason it is necessary that the minimum sized threshing and cleaning mechanism in a combine be amply large to meet these severe conditions.

It also will be found that in all separating and cleaning devices employed in combine harvesters the length of travel in process of separating and cleaning of the grain cannot be appreciably shorter in a small combine than in one of larger size. Therefore, it is probable that difficulty would be encountered in the marketing of a combine, even if efficient, with a shorter cutter bar, as the relative cost per foot of cutter bar would be greater in the small machine.

The problem of weight is an important factor to be considered in a combine harvester. This is not only true of the combine for the small farm but applies to combines of all sizes. Unnecessary weight in a combine adds to the farmer's tractor fuel bill in all cases and when the fields are soft and soggy it becomes a serious problem.

It would seem desirable that a combine harvester to be practical for the territory we are discussing should embody the following:

1 Capacity to handle any of the coarse-strawed crops and rank weed growth, and to do a good job of cleaning under those conditions

2 Such a width of cut as would work out to advantage in cost per foot

3 Ability to cut close to the ground, preferably as low as 2 in, with a sickle speed fast enough to cut clean at the greatest ground speed of the machine that it is practical for the average operator to guide the cutter bar over the ground

4 Light weight without sacrificing strength of construction; ample carrying area in the ground wheels and proper weight distribution on this carrying area

5 Dependable drives at all points and important drives protected by safety clutches

6 Interchangeable parts as far as possible, especially in bearings.

In addition, it would also be desirable to have some practical method of saving the straw.

Discussion by F. N. G. Kranick[4]

IN HIS PAPER Mr. Hurst cites a demand for a one-man combine suitable for use with small, general-purpose tractors, yet with capacity for large volume. These two demands cannot be reconciled with each other, at least if the machine is to operate with the efficiency which is attained

[3]Engineer, Minneapolis-Moline Power Implement Co. Mem. ASAE.

[4]J. I. Case Co. Mem. ASAE.

with currently used combines of somewhat larger size. Since this efficiency in saving and cleaning the grain is largely responsible for the present popularity of the combine, and certainly should be deemed an essential among engineers, I cannot admit as engineering progress any small combine which does not approximate the efficiency of present combines—certainly to excel alternative methods of harvest in over-all efficiency in saving the grain.

The suggestion that the proposed small combine shall be driven via the tractor power take-off is especially inadmissible. Small tractors, as we now speak of them, simply do not have enough power to drive combines even though they be small. The proposal for independent clutching of the power take-off may have its merits, but it will not overcome this inherent lack of power. Even if the tractor had sufficient power, transmitted by an independent clutch, it is highly improbable that, in the hands of typical farmers, the power delivered to the combine would be held within the speed limits essential to efficient threshing, separating, and cleaning.

The paper by Messrs. McCuen and Silver[5], also presented on this program, has demonstrated in exact terms what has long been known by practical threshermen and makers of threshing machinery—that the speed of threshing elements, notably cylinders, racks, and shoe, is quite critical, and that small deviations produce relatively large losses. Disregarding non-conventional designs for one and another of these elements or substitutes for them, all of which have been tried and found wanting, the threshing, separating, and cleaning elements of combines are essentially the same as those of threshers, and must conform to the same requirements.

Hence speed of the various parts must be accepted as a constant, and capacity to handle volume with efficiency must be a function of size. Again the Ohio tests show that there is an optimum and a maximum loading for each unit of width or area which should be respected in either thresher or combine.

Volume as a measure of threshing capacity (and equally of power requirement) is exceedingly hard to define. As long ago as 1918, in addressing the National Implement and Vehicle Association (now the Farm Equipment Institute) I pointed out the inadequacy of prevailing ratings in terms of bushels per hour, and urged that such ratings be more closely defined by specifying some standard yield per acre, so as to reduce the extent of variables involved. Tons of straw, or rather of unthreshed bundles, handled per hour, as now used for a unit by the Ohio men, I then opposed as being unfamiliar to the thought and practice among farmers. Among engineers it is a step in the right direction, but it still is defective in ignoring the ratio of grain to straw, even as my own proposal ignored variations in the amount of straw which may accompany a stated number of bushels per acre.

Before passing this point, it should be emphasized that there are qualitative variables at least as important as the measurable quantities. Among them are variety, such as the difference between Turkey Red and Velvet Chaff wheat; degree of ripeness at which cutting was done; moisture, not only as apparent in the material but even in the accompanying humidity; the presence of weeds; and seasonal or soil variations affecting the toughness of the straw.

If we can assume a properly corrected definition of volume, it is a relatively simple matter to design and build the thresher part of a combine, large or small, to deal efficiently with the desired volume per hour. So far as threshing, cleaning, etc., are concerned it matters not whether we get that volume with a wide cutter bar moving slowly, or with a narrow cut at higher speed. Of course, the product of these two must be adjusted to the volume per acre of material to be threshed.

It should be apparent, therefore, that speed of travel cannot increase the capacity of the threshing part of a combine. Increased speed may reduce the width of cutting members needed to gather the desired volume, and if the speed be high enough, it is conceivable that the width of cut could be reduced not merely to the width of the cylinder, as has been proposed, but to a still narrower point. Speed of travel, however, runs into its own problems of practicable sickle speeds and the rather critical matter of reel speed in relation to the inertia and other properties of the material.

In this connection I question the wisdom, if not the propriety, of engineers outside the thresher or combine industry laying down features of design. I believe it sounder for such engineers to concentrate on accurate definition of crop conditions and job requirements, leaving to the ingenuity and resourcefulness of designing engineers the mechanical construction which may most efficiently and economically satisfy those requirements.

Since "small" may refer to size, capacity, or price, it would be well for this Society to define just what is meant by a small, medium, or large combine. Small size is adapted to small farms and fields; small price to small incomes, of which we have too many; and small power requirement to the small general-purpose tractor of which we may expect an increasingly important number. Assuming a vague combination of all these, at least two facts should be borne in mind.

One is that while small combines can be just as efficient as larger ones, they cannot be built at so low a cost per unit of capacity. As above stated, there are no short cuts to big capacity with small size. Hence in terms of capacity per dollar invested, we must avoid making the combine so small and so cheap that it will cost too much.

The other consideration is that nearly all small machines, and especially those of which we are speaking, are worked at higher intensities per unit of size; in fact, are rather commonly overworked. Besides the probable adverse influence on grain saving and cleaning efficiency, this will call for higher quality or relatively larger size in such things as bearings and structural parts. This means increase in weight and cost that in some measure will defeat the purpose of the really small combine.

Considerable talk has been given to rubber tires on the combine and on the tractor that pulls it. To the extent that rubber reduces rolling resistance and minimizes vibration without running into such bouncing as may be detrimental to good separation and cleaning, it will reduce power requirement and allow increased speed, other conditions permitting, but that is all. Flexibility in speed will help to compensate for variations in volume per acre of varying crops and yields, but high speed of itself can easily become uneconomic. Moving the tractor and combine is a major power requirement, and it is dubious progress to speed the outfit twice or three times around the field to handle the same volume as could be handled at a conservative pace with a wider cutter bar on the same combine.

In conclusion, let me emphasize once more that efficiency in saving and cleaning the grain is essential to any combine, large or small. Lack of this essential is, I believe, the reason for the failure of the supposedly revolutionary combines that have appeared, not only recently but at various times and places for perhaps a generation.

[5] "A Study of Power Requirements and Efficiency of Threshing Machines," by E. A. Silver and G. W. McCuen. AGRICULTURAL ENGINEERING, April 1935, vol. 16, no. 4.

Land Classification and Soil and Water Surveys[1]

By Wilbur L. Powers[2]

SOIL AND WATER are our great enduring national resources. In 160 years this nation has grown from a population of 3 million to 125 million people and accumulated national wealth estimated at 320 billion dollars, largely originating from the soil. Though our forests be felled and our mines dug out, the people must continue to be fed. The soil has supported and must support all life. It is a basis of value which is not readily burned up or carried away. Land constitutes 65 to 75 per cent of assessed agricultural values. The water, which gives value to arid land and constitutes the perpetual supply of "white coal," is the other great basic resource. It is the alchemy that transmutes base clay into golden grain. It is a daily need of almost every living thing. Water is the key to arid land use.

The modern soil survey has a natural, logical, scientific basis. A mature soil is a natural, dynamic body with characteristics formed according to the climate and related vegetation it produces. The great climatic soil provinces of the world correspond to the orders in plants. The soil groups correspond to plant families; the soil series to plant genus; the soil types are similar to plant species, yet having more simple names.

The soil survey is used (1) to give an invoice of land resources; (2) to guide county agricultural agents in advising farmers or other settlers; (3) to help determine irrigation or drainage requirements, and feasibility or crop adaptation and fertilizer needs; (4) to assist in locating stable roadways; (5) to serve as a foundation for developing a permanent system of agriculture for each type of soil and every farm; (6) to help stabilize agriculture and lessen the guess work in farming, and (7) to give a basis for rationalization of land assessments. When completed, the soil survey is needed as a foundation for land-use planning and a crop-adjustment program.

The USDA Bureau of Chemistry and Soils has worked with the state agricultural experiment stations in one of the outstanding and best correlated examples of long-time cooperative teamwork. The soil survey costs about two cents an acre. Where topographical maps of the U. S. Geological Survey are available, this saves about one-half the cost in soil survey field work.

Soil survey data is fragmentary. Nearly one-third of the agricultural acreage of the country has modern detailed soil surveys. Another third has old reconnaissance surveys, which need to be reworked in detail. The remaining third is unsurveyed. In addition, some 390 million acres of grazing lands await reconnaissance survey and classification. So the foundation data are only partly prepared for the superstructure of land and irrigation economics. Would not much money and difficulty have been saved if soil had been surveyed and classified and water resources more adequately measured?

The general appropriation for PWA projects for 1933 and 1934 totalled $3,700,000,000, while provision for the federal soil survey work dropped from $307,705 to $199,891 a year, and as a consequence some of the few well-trained and experienced soil surveyors have gone into other fields of work. Even at the former rate of progress, the soil survey will not be completed for use of those now living. As a fundamental basis for agricultural progress, it is obvious, however, that the soil survey and land classification and chemical inventory should be completed before the soil is worn to the point of unprofitable production.

To complete the soil survey and classification in the next ten years according to estimates secured by request made to official agencies, with allowance for economic and chemical studies, would require approximately $2,000,000 a year for the ten-year period.

Funds for national soil and water survey and land-use project would prove to be of enduring value. Allotment has been made in the amount of $10,000,000 for a soil erosion service, which is a phase of a national land-use program applicable to certain areas.

The water resources branch of the U. S. Geological Survey was organized and developed by that great soldier, geologist, scientist, and builder, Major John Wesley Powell. His report to Congress in 1878, as director of the U. S. Geological Survey, astonished the reading public by the statement that there was only water for reclamation of 10 per cent of the arid West. A pioneer planner for use of fundamental resources, he secured withdrawal of public funds for future reservoir sites. He initiated the federal land reclamation policy, and had the satisfaction of seeing the Reclamation Act signed by President Theodore Roosevelt.

A topographic and map service of the Geological Survey is excellent. Where topographic base maps are not available, airplane photographs will be cheapest and quickest. In the same way that the Geological Survey was initiated by Powell, the modern soil survey was developed by that greatest living authority on soil science and land classification, Dr. Curtis F. Marbut. The reports and soil series are correlated by this agency.

It is of first importance that these well-established bureaus be maintained and utilized in planning, and that the work of existing agencies be fully utilized in national and state planning. The normal work of the water resources branch of the U. S. Geological Survey costs approximately $700,000 a year. Any moderate additional requests, as for emergency ground water surveys, may perhaps be best estimated in detail and taken to the Director of the Budget by the several states through their congressional delegations. The appropriation needs to be increased to at least $1,000,000 a year.

Any large expansion of water topographic surveys should be planned with the knowledge that hasty work may not be the best work or by the best trained men.

Land classification is of growing interest in connection with economic and social adjustment needed in a planned program of land use. Some progress has been made during the past quarter of a century in developing procedure for land classification (1) in connection with feasibility and rehabilitation surveys of some 3,000,000 acres in reclamation projects in the Pacific Northwest, and (2) in the economic use of soil surveys of some 7,000,000 acres largely in the humid section of Western Oregon.

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[1]Published as Technical Paper No. 216 with the approval of the Director of the Oregon Agricultural Experiment Station as a contribution from the Department of Soils. Also presented in substantially the same form before the National Reclamation Association at Salt Lake City, Utah, December 8, 1934.

[2]Soil scientist, Oregon State Agricultural College. Mem. ASAE.

The aim in economic classification of land is to show what use is economically most desirable under existing or prospective conditions or needs. Economic planning is involved, with provision for modification as conditions change. Economic classification will be less permanent than physical classification. The procedure and extent of detail will depend upon the aim and need at the time the classification or land-use program is carried out.

In making an irrigability classification similar to that defined in the so-called Fact Finder's Law of 1926 for federal reclamation projects, a detailed soil survey is very helpful. A form for recording conditions on each forty as used by Johnston and Powers on Sunnyside Division, Yakima Project, Washington, is shown in Fig. 1. Experience has shown that it is best to have but few classifications as to irrigability of land. At higher elevations in the Northwest two classes of economically irrigable land may be all that is practicable. Average yields or productivity classes, water duty, or construction charges based on classes will not be established unless the classes are few. Usually six classes or less are made.

Class 1 should include the best irrigable soil, having smooth topography, good drainage, water capacity, and fertility.

Class 2 will be only fair in some respects.

Class 3 will have more pronounced faults and may be nearly marginal economically.

Class 4 may not be used or may include salty pasture to which waste water may be rented.

Class 5 includes temporarily water-logged salty land as in the Fact Finder's classification.

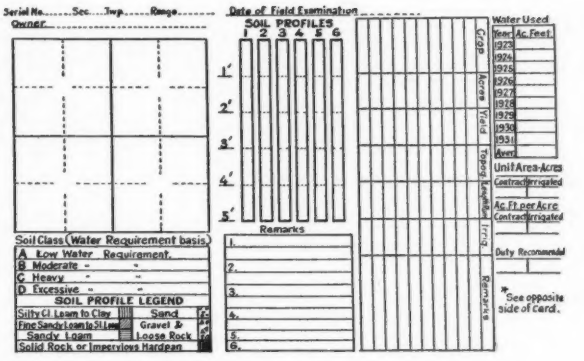
Class 6 includes the physical eliminations or non-irrigable land.

In the course of rehabilitation surveys on some three dozen reclamation projects during the past eighteen months, some 44,000 acres have been eliminated due to inferior soil or deficient water supply. In recent years 100,000 acres have been so eliminated from projects in Oregon because of inferior soils or other limiting factors. This is in line with the policy of developing the best land first. The present is an appropriate time for consolidation rather than expansion.

Good soils may be interspersed with submarginal land so that in certain areas farm units cannot be formed and supplied with water or other services economically. Experience and experiments show that land with a concentration of black alkali, indicated by a reaction value of about 9.5 *pH* or higher (where pure water or neutrality represents the reaction value of 7.0 *pH*), is uneconomic of reclamation except in small areas or spots, by known methods under prevailing conditions. In northwestern United States land is eliminated from general farming under irrigation where the slope exceeds 10 to 12 per cent, where the soil depth is less than 16 to 18 in, or where the soil water capacity is below about ¾ in per acre foot. Choppy topography, impervious hardpan, stone, cost of clearing, land-locked pockets, remoteness, or exposure may render land uneconomic of inclusion in reclamation undertakings.

Field work in recent years has involved culling out steep, stony, shallow, alkaline, or otherwise infertile or uneconomic areas from reclamation projects initiated during earlier optimistic times when farm products were at peak prices. Land classifications have been used in connection with rehabilitation and refinancing of reclamation projects, and they help determine ability to pay.

A detailed soil survey of a given area may show as many as 30 to 40 distinct soil types. In utilizing such a survey in a reclamation program, these soil types may be grouped into a few classes. Several of the soil types may have similar topography, depth, texture, fertility, and water capacity and can be placed in one duty-of-water class. For the purpose of fixing irrigation requirements in a given area, it is only practicable to have a few duty-of-water classes.



A form used by the author in a duty-of-water classification

In classifying some drainage districts within irrigation projects, the plan of classification used has been similar to that employed in classifying irrigable lands. In the humid Coast section, the soil within a dyked drainage district has frequently been fairly uniform as to quality, yet encountered in different classes due to different stages of improvement. Good soil occupied by willows and alders has been rated as temporarily untillable and placed in Class 5. Where the land was slashed and burned and in a stump pasture, it was then classed third grade. Land needing a little further grubbing and interior drainage has been placed in Class 2, and well-drained, firm land capable of being employed in a crop rotation or for rather intensive crops has been placed in Class 1.

Distinction should be made between physical classification and an economic classification. Much technical work has been done from one or more physical standpoints, such as soil surveys, topographic surveys, and ecological surveys. These may serve as a land inventory without regard to transitory, social, or economic conditions affecting land use. The National Land-Use Planning Committee agreed that a physical classification will be most helpful if it is related to the several physical factors, such as soil, topography, native cover, climate, natural drainage, and soil reaction, which collectively may affect the land type. Such physical surveys will constitute an important basis for an economic land classification. There is a relation between fertility grades and land classes. On the other hand, land classification involves such economic and social factors as land income, productive value, type of agricultural use; ownership; taxes, mortgage and other indebtedness, or overlapping obligations; population density and trends; markets; transportation, roads, and schools.

More adequate data are needed as to crop-growth rate, carrying capacity or yields for a period of years. Annual crop census data such as those accumulated by the U. S. Reclamation Bureau on its projects, cost of production and price trend studies, such as developed by the agricultural experiment station, are of increasing value in economic land classification or appraisal.

The detailed soil survey gives a scientific basis for an economic land classification or for making agricultural adjustments or zoning for a program of land utilization. For

example, a detailed soil survey of Willamette Valley watershed outside the national forest has been completed in the course of fifteen years' cooperative work between the Oregon Agricultural Experiment Station and the USDA Bureau of Chemistry and Soils. The area surveyed is nearly 5,000,000 acres. This gives us a picture of the land resources. Over half of this area is in the foothill group of soils; approximately one-fourth is old valley filling soils, and the remainder recent stream bottom land. Approximately 466,000 acres has poor drainage, and an additional 407,000 acres has imperfect drainage. The area well suited for supplemental irrigation is 740,000 acres. There are 419,000 additional acres of fair irrigability, making something less than a million acres needing drainage and over a million acres needing supplemental irrigation. Half a million acres belonging to such soils as the Chehalis of the second bottom and the Willamette of the main valley floor are lands of first-class character. They belong to the great brown earths in the world system of soil grouping and are well situated for intensive development. Four soil series least desirable for cultivation and largely in grass at present total approximately 100,000 acres. Nearly a million and a half acres of foothill lands between the forest and the farms are largely suitable for pasture and with judicious seeding and fertilization can be greatly improved in carrying capacity. The recent soils in this area are unleached and lime is not needed on them. The valley floor soils need lime, especially the wet type following drainage. The hill soils are generally distinctly acid. Ground limestone to the amount of a quarter of a million tons annually could be used to correct and maintain a favorable reaction on these lands.

How Soil Survey Gives Basis for Land Classification and Use

A detailed land classification and culture survey based on this soil survey would be desirable and would call for grouping into at least three classes of tillable land, perhaps as many classes of pasture land, as well as the various lands suitable for forestry, for industrial and residence sites, and for recreation and game preserves.

The Willamette Valley has been used as an example to show how the soil survey gives a scientific basis for land classification and use.

A program of land and water use, based partly on the ten-point program of Oregon Reclamation Congress, may well include:

1 Completion of the soil survey, especially of agricultural areas, and a land classification based thereon.

2 Extension of a program of soil analyses fertilizer research based on the soil survey.

3 A study of water control by irrigation or drainage, to avoid alkali, control acidity, prevent erosion, and secure efficient soil moisture use.

4 An invoice of soil organic matter.

5 Utilization of land products and "waste materials on the farm so that they may become the raw materials of industry."

6 Use good lands first and return marginal lands to pasture, reforestation, industrial or recreational use, and allow fertility to accumulate until there is a more definite demand for other higher use.

7 Drainage areas necessary for future water supply should be protected against destruction of immature timber and vegetation.

8 A program of deferred, regulated grazing on the public domain.

9 Efficient land use should lessen cartage, and afford more protection for local markets and for local growers.

10 Use of land for recreational purposes will become of increasing importance. Let us provide a balanced land-use program for farm, forest, grazing, industrial, and recreational purposes. Such a program should permit utilization of all our lands most profitably.

The North Dakota Agricultural Experiment Station has recently requested the Federal Emergency Relief Administration to set up a national project on land classification. Such a project should be national in scope, as all states are concerned in readjustments of land use. A national project might take ten years and would permit seasonal shifting of field men to regions of open winters. The cost is estimated at less than 2 cents an acre classified. A trained personnel required for this work is available. Land planning and land-use maps will permit zoning and help to avoid maintaining highway and school facilities in remote and sparsely settled areas of low productiveness.

Recommendations for a Study and Classification of American Soils

Undersecretary of Agriculture Dr. Rexford G. Tugwell in support of such a program recently stated (Extension Service Review 466): "We must study and classify American soils, taking out of production not just one part of a field or farm, but whole farms, or whole ridges. We must determine which lands are best suited for the commercial production of staple crops, which had best be put back into trees, and which should not be used for agriculture at all but simply provide places for recreation and residence."

The author, therefore, offers the following recommendations:

1 A national water survey and land-classification project is fundamental to an agricultural adjustment and land-use program. Where possible it should be based on a soil survey and include a land classification and culture and classification maps.

2 Detailed soil surveys should be extended rather than reduced at this time, for they are fundamental to a land and water-use program.

3 Lands formerly opened to homestead are largely submarginal and best suitable for grazing. There public lands might best be placed under one single administrative agency and zoned.

4 Land social and economic and biological values should be safeguarded against exploitation. Strict licensing of land dealers might help provide for this.

5 Research may well be an important feature of any planned program for orderly utilization of our national resources. Pasteur said, "A few great scientific discoveries and their application is the way to progress."

A system of agriculture that is to preserve the soil fertility and avoid destructive erosion permanently must be profitable. It must increase yields per acre on good land and decrease unit costs by economic methods, such as crop rotation and utilization of farm wastes. It is time to put a program of land planning and use into effect now, for it is cheaper to keep good soil productive than to restore fertility of exhausted land. Only soil utilization based on a fact-finding and fact-assembling program with mapped soils and classified lands will bring all soil work "down to earth" and make possible and stable the highest productive land values and the greatest human security.

The Design of a Double-Piston Pressure Regulator for Spray Pumps

By K. R. Frost[1]

THE PRESSURE regulators used at present on orchard spray pumps vary in design and construction but function on similar fundamental principles. Some regulators use pistons and others diaphragms to actuate the by-pass relief valve, although the check valve is employed by both types to provide a means of unloading the power unit while the spray lines are closed. Regulator troubles have been prevalent since the advent of the power sprayer, mainly due to the corrosive and abrasive materials in the spray liquid and the high velocities at restricted areas in the regulator. In order to avoid trouble, removal of the check valve has been recommended by some operators. This practice merely converts the regulator into a simple relief valve which is no better than the safety valve used on positive acting pumps, and the purpose of unloading the power unit for which the regulator was designed is defeated.

Two remedies are necessary in order to make the standard type regulator function satisfactorily. These are (1) proper reseating of the check valve at several intervals during the operating season and (2) a means of increasing the opening of the by-pass valve in order to reduce the velocity below the critical point of abrasion. It is possible to do the latter with the piston regulator because of the large available movement of the valve stem. However, this feature does not eliminate undesirable leakages at the valve seats. The only practical solution to the problem appears to be the substitution of a piston and by-pass port for the relief valve and a perfectly seated check valve. This arrangement with two pistons properly balanced with a spring will provide adequate movement of the by-pass port and reduce the back pressure on the pump to a minimum. An experimental regulator was designed and built employing these features and is termed the double-piston regulator because two pistons function as a single unit for providing a means of unloading and pressure regulation.

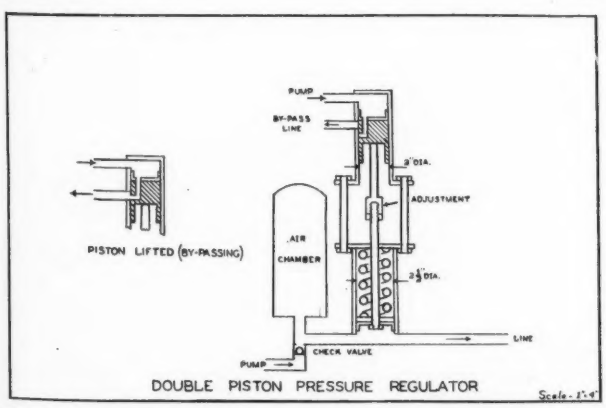
The double-piston regulator functions similar to the other types, but differs in amount of by-pass valve lift made possible by a weaker spring as the pressure on the upper piston practically counteracts the force against the lower piston until the by-pass ports open. The instant the port opens the pressure on the upper piston is decreased; therefore, the check valve is closed suddenly and the energy stored in the air chamber lifts the two pistons upward uncovering the full area of the port. This reduces the back pressure on the pump and the horsepower output of the power unit.

The operation of the double-piston pressure regulator depends on certain physical laws. These are covered in the two force equations, $C_1 = P\ (A_1 - A_2)/S$ and $C_2 = P\ A_2/S$, which define the distance the piston moves before the by-pass port opens (C_1) and the distance after the port opens (C_2). P is the operating pressure; A_1, the area of the large piston; A_2, the area of the small piston, and S, the force necessary to compress the spring one inch (spring constant). Such values for these symbols were chosen and substituted in the above formulas so that there was sufficient lift of the piston to reduce the back pressure to 10 lb per sq in. The following substitutions were used and the regulator designed accordingly: $P = 500$, lower piston diameter $= 2.5$ in, upper piston diameter $= 2$ in, and spring constant $= 4400$ lb per in.

The regulator was tested on a spray pump discharging 20 gpm. The operating pressure was varied between 200 and 600 lb per sq in by means of the adjustment screw indicated in Fig. 1. An electric meter and a motor efficiency curve were used to determine the horsepower consumption for each test, and pressure gauges connected to the pump side and spray line side of the regulator indicated the by-pass and operating pressures, respectively. These readings are recorded in Table 1 and plotted graphically in Fig. 2 as compared with the operating characteristics of the standard regulator.

It was found during the tests that a slight interval of time was required to build up pressure when the lines were reopened. Larger air chambers increased this time interval and stiffer springs decreased it. The proper size of air chamber and spring will reduce this lag to an amount which

[1]Associate in agricultural engineering, University of California. Jun. ASAE.



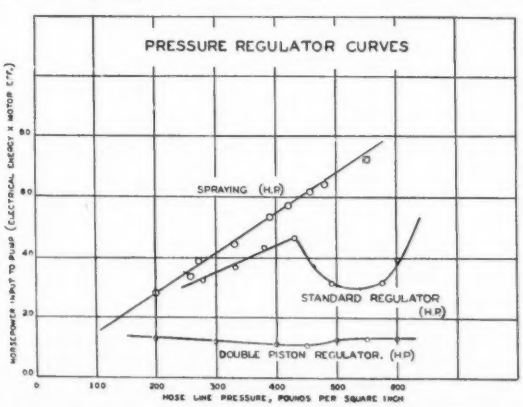


Fig. 1 (Left) Cross-sectional diagram of the double-piston regulator showing two positions of the by-pass port. Fig. 2 (Right) Double-piston pressure regulator curves showing operating characteristics

TABLE I. THE OPERATING CHARACTERISTICS OF A DOUBLE-PISTON TYPE PRESSURE REGULATOR

Operating pressure, lb/sq in	Unloading pressure (by-passing) lb/sq in	Operating horsepower	Unloading horsepower	Piston lift to open port, in (measured)	Piston lift to by-pass, in (measured)
200	10	2.8	1.23	0.50	0.40
300	10	4.1	1.24	0.50	0.40
400	9	5.4	1.19	0.50	0.35
450	8	6.1	1.11	0.53	0.33
500	10	6.8	1.25	0.50	0.31
550	10	7.4	1.27	0.50	0.31
600	10	8.2	1.27	0.50	0.25

is favorable to operating conditions. The upper piston required lubrication with a pressure gun two or three times daily to insure free movement of these parts.

CONCLUSIONS

1 The double-piston regulator lowers the by-pass pressure and horsepower consumption to 50 per cent of that required by the use of the standard regulator.

2 This regulator is simpler to adjust as it is unnecessary to compress the spring or adjust the valve stem for clearance as must be done on other regulators.

3 Considerably less trouble and expense should result from the use of the regulator due to the large by-pass openings and the elimination of ball valves and stems which are affected by abrasion and corrosion.

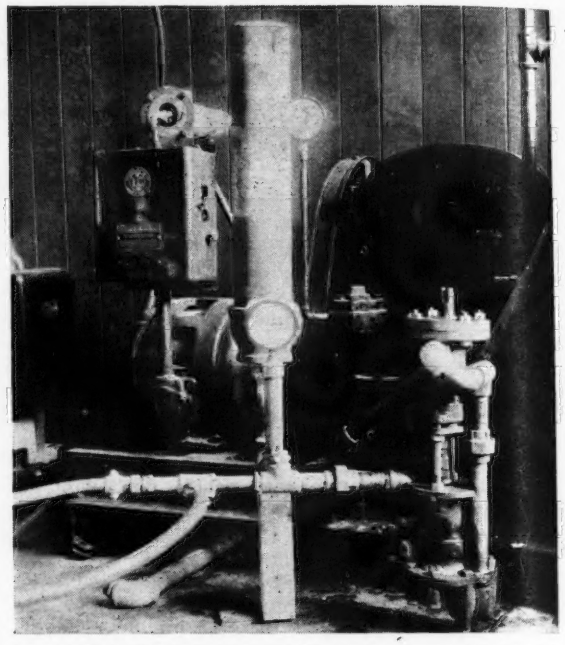


Fig. 3 Double-piston pressure regulator installed on a stationary spray pump

A New German "Baby" Combine

By Dr. Ing. W. G. Brenner

IN GERMANY we have worked several years on the development of small combined harvester-threshers and have attempted to apply to European conditions the results obtained overseas with American and Canadian combines.

The machine shown in the accompanying illustration is one which is specially adapted for use in the very tall, high-yielding grain of Europe, but it is also cheap enough to be within the reach of the smaller European farmers.

After several years of experimental work, the company building it has succeeded in developing a comparatively small-sized, large-capacity harvester-thresher which can be mounted on an ordinary sized tractor and driven from the power take-off. This large capacity resulted from technical investigations on threshing cylinders, which showed that enormously high capacities can be obtained without great increase in power requirements, if the grain is fed to the cylinder in a thin layer. This is especially necessary for European conditions as the large quantities of straw can not be fed through the machine without exceeding the capacity of the power take-off.

In operation, the grain is first cut with a cutting mechanism mounted in front of the tractor and then, by means of a specially designed chain, is inverted so that the heads hang downward. In this position the grain passes into the cylinder, which is mounted in a vertical position at the rear of the tractor. As a result of the vertical arrangement of the threshing cylinder and the inverted position of the grain, it is possible to completely thresh the grain without shattering, and thereby reduce the amount of the thresher mechanism. The thresher mechanism which is mounted behind the tractor proper consists solely of a vertical cylinder and a powerful air cleaner with sieve, as well as a chain which discharges the straw at the rear.

The machine has a cutting width of 2½ m (8.2 ft). In normal forward travel of the tractor in first or second gear, this means an output of 2,000 to 2,500 kg per hectare (29.7 to 36.8 bu [wheat] per acre) in high-yielding grain, so that the capacity of this baby combine compares very favorably with that of steam threshers. In turning this machine at the ends of the field, the sacks of threshed grain may be dumped off, but, of course, the average capacity of a day's run would be reduced. It is possible to harvest 5 to 7 hectares (12.35 to 17.4 acres) in 10 hr with this machine without difficulty.

Of especial note are the advantages of the cutting mechanism. It is not necessary to open the field by first cutting a small portion by hand. This *(Continued on page 246)*

The picture shows the new German "baby" combine, described by Dr. Brenner, mounted on a standard four-wheel tractor. It was developed by Gebr. Class, German manufacturers

Agricultural Engineering Digest

A review of current literature by R. W. TRULLINGER, senior agricultural engineer, Office of Experiment Stations, U. S. Department of Agriculture.

POLLUTION OF WELLS AND ITS PREVENTION, *W. Rudolfs.* N. J. Agr. Col. Ext. Bul. 127 (1934), pp. 8, figs. 2. Practical information is given on the manner in which wells become polluted, the character of the polluting material, and methods for the prevention of pollution. Water treatment by heat and chemical disinfection also is briefly described.

THE EFFICIENCY OF USE OF FARM POWER, *H. R. Robson* and *G. L. Shanks.* Sci. Agr., 14 (1934), no. 10, pp. 565-568, fig. 1. Studies conducted at the University of Manitoba are reported in which a series of forty-five drawbar tests were conducted of power machines. The tests made included ten horse outfits and thirty-five tractor outfits. Plows, disks, and cultivators were the implements being hauled by horses, while the tractor loads comprised plows, disk tillers, cultivators, and twelve combines. The size of outfits varied from 3 to 8-horse, and the tractors varied in the maximum drawbar horsepower from 8.25 to 33.2 hp.

The results indicate that horse outfits are more likely to be loaded to capacity than are tractor outfits, that higher overloads will be found with horse outfits than with tractor outfits, that the smaller tractors are more nearly loaded to capacity than the larger tractors, and that as the size of the tractor increases the probability of it being loaded to capacity decreases.

The ease with which the number of horses used may be varied to suit the draft requirements of an implement is an important advantage of horse-operated implements which is not usually stressed. As the draft of any implement varies with soil types, depth, and soil condition, the tractor-operated machine must be of a size that its draft under the worst conditions will not exceed the tractor's capacity. This means that under more favorable conditions the tractor will be underloaded as shown in the tests.

THE USE OF CONCRETE ON THE FARM, *J. C. McCurdy.* N. Y. Agr. Col. (Cornell) Ext. Bul. 285 (1934), pp. 28, pl. 1, figs. 26. Practical information is given.

BELTS AND PULLEYS, *W. C. Krueger.* N. J. Agr. Col. Ext. Bul. 126 (1934), pp. 13, figs. 11. Desirable practices and data pertaining to the use of belts and pulleys on the farm are briefly presented.

CONGRESS OF AGRICULTURAL MACHINES. Congres de la Machine Agricole, 1933. Compte-Rendu. Paris: Impr. Lang, Blanchong & Co., 1933, pp. 309, figs. 170. Brief descriptions are given, with some illustrations of the different machines exhibited. These included soil-preparing and harvesting machinery, tractors, agricultural-product processing machinery, rural electrification equipment, and internal-combustion engines adapted for agricultural use.

THE INDUSTRIAL UTILITY OF PUBLIC WATER SUPPLIES IN THE UNITED STATES, 1932, *W. D. Collins, W. L. Lamar,* and *E. W. Lohr.* U. S. Geol. Survey, Water-Supply Paper 658 (1934), pp. IV + 135, pl. 1, fig. 1. This report presents analyses showing the composition of the public water supplies at 670 places covering 46 per cent of the total population of the United States.

BRIEF INSTRUCTIONS FOR THE DESIGN AND CONSTRUCTION OF SMALL DAMS FOR EMERGENCY CONSERVATION WORK IN NORTH DAKOTA, *L. C. Tschudy* and *J. G. Sutton.* U. S. Dept. Agr., Bur. Agr. Engin., 1934, pp. 24, figs. 13. These instructions cover the design and construction of small dams suitable for Civilian Conservation Corps work in North Dakota. The dams to be built are intended primarily to store water for flood control and water conservation purposes and to raise the water table in bottom lands.

ALCOHOL-GASOLINE ENGINE FUELS, *H. Miller.* Idaho Sta. Bul. 204 (1934), pp. 29, figs. 12. Field and laboratory tests to compare gasoline and gasoline-alcohol mixtures in internal-combustion engines are reported, together with the results of a survey of practices in foreign countries relative to the use and production of alcohol and its byproducts.

The three methods of using ethyl alcohol with gasoline as engine fuel tested included blending absolute ethyl alcohol with gasoline; blending commercial ethyl alcohol with gasoline through the use of blending agents, such as propyl, butyl, and amyl alcohols, benzol, or acetone—and using a double-bowl carburetor and mixing the two fuels in the vapor phase. Compression ratios of 5.5:1 and 6.35:1 were used.

In a four-cylinder engine a blend of 10 per cent absolute alcohol and 90 per cent gasoline gave performance practically identical with gasoline. It did not, however, knock at the heavier loads as did gasoline. In the blend containing 29 per cent commercial alcohol the performance of the gasoline was superior at loads less than 5 hp, while at the higher loads the reverse was true.

The carburetor on the same engine was modified in order to burn a lower purity of alcohol.

In using 10 per cent alcohol of 95 per cent purity the performance of the mixture at the lower compression ratio was inferior to that of gasoline at all loads. At the higher compression ratio the performance of the mixture was superior at loads greater than 4 hp.

Similar tests were conducted with the 5.5:1 compression ratio for similar proportions of alcohol of 90 and 85 per cent purity. The increased amount of water in the alcohol did not affect the performance materially.

Road tests were also conducted with the same engine. The car was driven over a distance of 300 miles for each test to eliminate as far as possible the error due to normal variations in the road conditions. Tests were made with the standard cylinder head giving a compression ratio of 4.22:1 and with a special head giving a compression ratio of 5.5:1. At the lower compression ratio on the road, as well as in the laboratory, the performance of gasoline was superior to the mixture. The grade of gasoline used in the first test could not be used with the higher compression ratio due to detonation. At the higher compression the performance of the blend was superior to the premium gasoline by 6.15 per cent. The premium gasoline knocked readily during moderate acceleration. The blend could not be forced to knock. Consequently the compression ratio could have been raised considerably and the mileage increased still further.

It is concluded that the successful use of ethyl alcohol as an engine fuel and antidetonant depends on the compression ratio of the engine.

AGRICULTURAL ENGINEERING INVESTIGATIONS AT THE IDAHO STATION. Idaho Sta. Bul. 205 (1934), pp. 16-22, 69, 70, 71, figs. 2. The progress results are presented of studies on alcohol-gasoline blends for internal-combustion engines, the use of Idaho materials for construction, poultry houses, shelter sheds, electrical soil heating, electrical grinding and mixing of feed, use of Diesel tractors, deep tillage, efficiency of drainage and irrigation pumping, and rod weeders.

AGRICULTURAL ENGINEERING INVESTIGATIONS AT THE MARYLAND STATION, *R. L. Sellman.* Maryland Sta. Bul. 362 (1934), pp. 365-368. The progress results are presented of investigations on the upkeep of farm implements and machinery, and on the corn binder with elevator for harvesting silage corn.

AGRICULTURAL ENGINEERING INVESTIGATIONS AT THE VERMONT STATION. Vermont Sta. Bul. 380 (1934), pp. 14, 15, 16. The progress results are presented of studies of dairy plant efficiency, harvesting immature forage for drying, and operation of a mechanical hay dryer.

AGRICULTURAL ENGINEERING INVESTIGATIONS AT THE NEW JERSEY STATIONS, *E. R. Gross* and *W. Rudolfs.* New Jersey Stas. Bien. Rpt. 1932-33, pp. 13, 14, 91-94. The progress results are reported of investigations on fertilizer distributors, ventilation requirements for poultry laying houses, mechanical means of projecting air for dusting, and tillage machinery, and on water and sewage research.

THE PHYSICAL PROPERTIES OF LUMBER, *G. P. Ivey.* Hickory, N. C. Southern Pub. Co., 1934, pp. X + 263, figs. 64. This book contains practical information on the physical properties of lumber. It contains chapters on properties of woods in general; the grading of lumber; weight of lumber; hardness of lumber; shrinkage of lumber (both radially and tangentially); strength, elasticity, and crushing strength of lumber; production of lumber; and description of the principal species of trees. *(Continued on page 238)*

Col. Zimmerman Raised to Honorary Membership

IN THE ELECTION recently of Col. Oliver Brunner Zimmerman as an Honorary Member, action by the American Society of Agricultural Engineers is both tardy and premature; tardy because other societies and institutions have led with comparable honors, and premature because it has not been the custom of the ASAE to bestow this distinction on men so seeming young and so surely active in Society affairs and professional productivity.

OLIVER B. ZIMMERMAN

To all but the newest members Col. Zimmerman already is an old friend, familiar through fifteen years of consistent attendance at meetings, the presentation of notable papers, by sound criticism simply stated in technical discussions, never-ending industry in committees and other official capacities ranging up to that of President of the Society, and by a courageous, far-sighted optimism in the affairs of the Society and in the broad realm of engineering. To those denied the pleasure of his personal acquaintance he is known by his scholarly contributions to this and other technical journals. Among these a few of the more significant are: "Instant Angular and Linear Velocities in Complex Mechanisms," "Intra-Company Standardization," "Coordination of Theory and Practice in Design and Operation of Plows," "Tractor and Plow Reactions to Various Hitches," "The Application of Machinery to Agriculture," and "The Technical Determination of Stress Surges in Loaded Wheels."

Despite his gifts to the literature of engineering, Col. Zimmerman confesses a dislike for writing as such; yet urges it upon engineers not only as a duty of dissemination to colleagues, but as an aid to depth and orderliness of thinking, as inviting criticism with consequent caution in utterance, and particularly as defining outlines for further research or other progress.

Among the honors preceding the present one, Col. Zimmerman has been elected by order of the Council to life membership in the Society of Automotive Engineers; made a corresponding member of the Wisconsin Academy of Arts, Letter and Sciences in recognition not only of distinction but of active membership maintained for many years after his removal from the state; and was awarded the honorary degree of Sc. D. by Pennsylvania Military College, conceded second only to West Point in curriculum, prestige, and traditions.

This military degree was in token of outstanding achievement in the World War, from which developed the "Colonel," and in which he served in two principal capacities. The first was as Officer in Charge of the Mechanical and Civil Engineering Equipment Division where, with a remarkable personnel, he handled selection, purchase, and design of U. S. Engineers, Mobile Army, and Coast Defense equipment. The second was as Officer in Charge of the Research and Development Division, U. S. Army. A few of his striking accomplishments—we are tempted to say exploits—have been mentioned in these pages (August 1934) and space forbids enlarging on them now.

So, too, with any attempt to review the Colonel's career in industry and the connections it included; these also are of record in the issue cited. His major attachments, however, are neatly summarized in an incident he likes to recall. Lecturing on tractors one winter in Winnipeg, he was accosted by a huge man, made still bigger by a racoon coat, and backed up by some three-score similarly sturdy sons of the soil. (Be it known that the Colonel's stature bears no relation either to his athletic prowess or to the measure of his achievement.) In colorful Scandinavian idiom which defies black type the spokesman began:

"You worked for Hart-Parr Company?"

"Yes."

"You worked for the Rumely Company?"

"Yes."

"You work now for Harvester Company?"

"Yes."

"Who you going to work for next?"

It came to pass that he worked for the International Harvester Company for 22 years, exclusive of the war hiatus, in every important region of North America, several countries of Europe, and in parts of Africa. It was during this long period, both through the ever-growing caliber of the man and through the splendid opportunities and facilities provided by the company, that he carried on most of the research and development that not only served well his employer but strengthened the foundations and expanded the structures of engineering at large.

Not ignoring his great work, as Supervisor of Materials and Standards for the Harvester Company, in promoting intra-company standardization and improving materials specifications for purchasing methods, his culminating contribution was five years of intensive study into the functional stresses of wheels. The first comprehensive paper arising from these studies he presented at the 1934 ASAE annual meeting—fittingly at Detroit, the home of the wheel. Another paper was given at the December 1934 meeting of the Power and Machinery Division, and some six more are in prospect.

Yet his service to the technology and the profession of engineering is vastly more than incidental to his employment. Beside our own Society and the others already mentioned he has been a member of and active in the American Society of Mechanical Engineers, the American Society for Testing Materials, and other technical bodies to a total of ten, including the Committee on the Relation of Electricity to Agriculture and the National Committee on Corn Borer Control. During a total of 68 society-years he has served on some 290 committees, in many cases as chairman.

That this was largely a labor of love is apparent not only from the myriad hours of his personal time and energy that Col. Zimmerman devoted to it, but also in the zest with which he pursued it and the pride with which he recalls its various accomplishments, especially those culminating in American Standards through the agency of the

American Standards Association. It came to be almost axiomatic that when he was on a committee it moved—thoroughly and constructively. Moreover, under his leadership every committeeman had a chance to express himself, and in an atmosphere of frankness and fairness. These contacts, personal and technical, added much to the wealth of experience and perspective which increasingly have enriched his work.

One of the contacts he deems especially significant was the one in which he headed a delegation of ASAE members at the special invitational conference with President Coolidge at Rapid City in August, 1927. This conference, prolonged at the President's request to several times its appointed length, marked the beginning of a new influence by agricultural engineers in national policy and of added authority for the ASAE.

Next to his family, his friends, and his profession, Col. Zimmerman's great love has been athletics, not merely as sport, but with all the implications of clean living, hard fighting, fair dealing, and good nature—sportsmanship as the gentleman knows it. As a youngster, shortly out of college, he was a teacher at West Division High School, in Milwaukee, and doubled as athletic coach. So well did his team perform that by the second year they were winning state championships. At the close of the third year, again filled with athletic success, his friends presented him the finest obtainable split-second chronometer works complete with gold case and chain—the same timepiece which, after 36 years continuous operation, he carries with undiminished pride today.

Quite out of keeping with his mild manner, his profession and more latterly his years, are the tales that have come to light about the Colonel's extemporaneous excursions into primitive combat. One was the case of the alleged oiler, a raw-boned Swede whose qualifications shortly turned out to be 208 pounds of enviable physique and a belligerent temperament. Found unfit at the work for which he was hired and imperilling the success of a complete, 36-hour thesis test of all heat, mechanical, and electrical equipment of a large hotel, he was "bawled out" by the future Colonel. At the time Zimmerman weighed 113 pounds. He dodged the blows with which the supposed oiler lunged at him, trying out a non-aggression policy. Shortly he was cornered among the hazards of moving belts and machinery. Without going into the technology of wrestling—the telling would take longer than did the doing—the Swede was thrown to a four-point landing, held, released, paid off by the others, and eliminated.

In another encounter, with a weight ratio of 126:186, the Colonel surprised a burglar in the act of forcing entrance to the Zimmerman home. Throttling the miscreant, the battleground shifted from porch to walk to parking, where knee-action to the chin gave the burglar the long count; after which he was hauled indoors and shown the front elevation of a double-barrelled shotgun pending arrival of police.

We have here largely neglected the engineer we know in order to present some non-apparent aspects of the Colonel's life and personality. We dare not delve into the sheaf of documentary data which spotlights here and there the high achievement of and high esteem for an engineer, an organizer, an executive, a soldier, an athlete, and a man. Scattered among them are a treasure chest of letters from the high command, not only military but industrial and professional, which confirm the ASAE Council's judgment in elevating Colonel Zimmerman to the select company of honorary membership.

NEWS

AEC News Letter

PROGRESS under the work-relief program has been delayed during the past month, as the set-up at top has gradually taken form. Actual starting of jobs and hiring of men still awaits the approval of individual projects by the new chain of federal boards which have been placed in control.

The set-up, briefly, at this moment, starts with a division of application and information, headed by Frank C. Walker, director of the National Emergency Council. Applications for projects are passed from there to an allotment division under Harold L. Ickes. With the President's approval, projects go to a progress division under Harry L. Hopkins who thus is in a key position in the supervision of actual work. Admiral C. J. Peoples, director of Treasury procurement, will handle purchase of materials under the Hopkins division. R. G. Tugwell is expected to take over subsistence homesteads and rural community projects. Rural electrification is tentatively under Morris L. Cooke.

Prominent engineers in the higher command include Maj. Gen. Edward M. Markham, chief of engineers; Dr. Elwood Mead (Hon. Mem. ASAE), commissioner of reclamation; and Thomas H. MacDonald, chief, Bureau of Public Roads, all on the works allotment division which takes its place in the alphabetical array as "WAD". Fred Schnepfe, director of projects, PWA, has been named secretary.

Two billion dollars are to be released from the works fund, according to present plans, for allocation to projects. This represents half of the $4 billions broken down in the April 15 News Letter. Each class of work (highways, rural electrification, etc.) get, for the present, one-half of the sum earmarked in the bill.

General policies stand essentially as stated last month. From recent Presidential statements, it is inferred that relatively small-scale projects, widely scattered, involving a high labor ratio, and possible of completion within a year, will be pushed forward rather than large undertakings, such as dams, where a huge sum would be spent in a restricted area on work which would take several years.

A department of conservation and works is proposed in a bill sponsored by Secretary Ickes and introduced by Senator J. Hamilton Lewis of Illinois. This is designed to permit the President to institutionalize on a long-term basis some of the activities which have developed under the emergency units of the government.

The survey of the engineering profession, by the U. S. Bureau of Labor Statistics in cooperation with Council and the engineering societies, at last goes forward. Delay was occasioned first by the compilation of the unexpectedly large mailing list of 170,000 names received from engineering groups throughout the country. This work was done in New York under the direction of George T. Seabury, chairman of Council's Committee on Engineering and Allied Technical Professions.

Heavy pressure of federal work at the Bureau has held up the mailing of the questionnaire forms over this big list until now. But the final plan is to complete mailing by June 1. *The closing date for blanks to be filled in and returned to the Bureau* has been set for *July 6*.

Secretaries of engineering societies are urged again to notify their members of the necessity of making prompt and accurate returns in order that the survey will yield a maximum of statistical guidance to the profession in working out its employment, salary, educational, and other problems. Good advance notice was made by the societies early in the year but this was premature for reasons we could not anticipate. It is easy for the members to forget.

We hope the matter will be brought up again at meetings, in bulletins, and otherwise so that the full importance of the survey will be realized by every engineer. It is esential that returns be 100 per cent

so that we will have something approaching a census rather than a mere sample. If any professional engineer, or anyone who has qualified as an engineer in the past, fails to receive a questionnaire by about June 10, he is requested to write Andrew Fraser, U. S. Bureau of Labor Statistics, Department of Labor, Washington, D. C., for one of the blanks.

The questionnaires may look formidable when you receive them but are mainly "yes" and "no" questions which can be checked off in a few minutes. *Do it now!*

Council's membership continues to expand under the new plan of nominal dues for state and local organizations. Nine societies already have made application, as previously reported, and five more are in process of applying.

Membership committees are being set up in each state to encourage more groups to join and to become participants in the steps which Council is taking toward the advancement of the profession. The state committees are being organized under regional chairmen in each of the nine major divisions of the country.

This system of committees is preliminary to the development of Council's regional public affairs committees which will permit engineering opinion to be voiced through joint action. The scattering of organizations and lack of coordination in most regions hitherto has led to a dispersion of effort.

The May 20 meeting in New York of nine functional units serving the engineering profession as a whole (see last news letter) brings these service groups into closer cooperation than ever before. AEC will present a map of the United States, showing the location of all the national, state, and local engineering societies and the local sections of national societies. The need for coordinating this far-flung system was made evident through the accompanying exhibits. Samples of Council's publications and statistical work also were on display. (President-Elect L. F. Livingston represented ASAE at this meeting.)

J. F. Coleman, president of AEC, will speak at the meeting. Council is organized for public service, he points out, and not for self-aggrandizement. The AEC organization is being perfected so that it may become more truly representative of the profession by including more of the groups eligible for membership. Coordination of existing agencies rather than the setting up of new ones, Mr. Coleman believes, is the logical route toward professional advancement and a more active participation in engineering affairs.

A digest of the Brookings Institution reports entitled "America's Capacity to Produce" and "America's Capacity to Consume" has been prepared by the Maurice and Laura Falk Foundation of Pittsburgh, Pa., through whose courtesy AEC has copies for distribution to engineers who wish to study the results of these basic surveys. Requests will be filled as long as our supply lasts.

A study of the civil service system in its relation to engineers will be made by Arthur W. Berresford, past-president of AEC, who has consented to do this unofficially and to make an informal report as a basis for action by Council. The maintenance of the federal "merit system" is of interest to large numbers of engineers in its relation to salaries, tenure of office, and methods of appointment.

Apprentice regulations affecting engineers have been changed by the federal committee on apprentice training in response to a request from Council. Under the apprentice listings, items formerly appeared for chemical, electrical, heating, structural, and ventilating engineers. But the apprentice system, with wages lower than standard, has been applied to engineers only if students in cooperative (part school, part work) colleges. Mr. Morrison Handsaker, administrative assistant of the committee therefore consented to segregate the engineers under a separate section, specifying that apprentice training should apply only under these colleges. This will remove any misunderstanding that might have tended to be against the interests of the profession.

When in Washington, don't fail to call at 744 Jackson Place, the Washington Embassy of Engineers.

New ASAE Members

Emilio Gomez Ayau, chief engineer, Provincial Service of Agrarian Reform, Seville, Spain.

Harry P. Bateman, engineer foreman, ECW Camp 75-DPE, Macomb, Ill.

Woodrow M. Brown, junior agricultural engineer, Soil Erosion Service, U. S. Department of Agriculture. (Mail) RFD 1, High Point, N. C.

Leon H. Cassity, assistant agricultural engineer, Soil Erosion Service, U. S. Department of Agriculture. (Mail) Box 134, LeRoy, Ill.

William P. Elam, agricultural engineer, Soil Erosion Service, U. S. Department of Agriculture. (Mail) Box 882, High Point, N. C.

George W. Endicott, principal foreman, Soil Erosion Service, U. S. Department of Agriculture. (Mail) Dixon Springs, Ill.

Walter M. Floto, manager, fence and post sales department, American Steel and Wire Co., 208 S. LaSalle St., Chicago, Ill.

F. L. Gibbs, agricultural engineer, Virginia Electric and Power Company, Richmond, Va.

Theodore R. Horning, junior agricultural engineer, Soil Erosion Service, U. S. Department of Agriculture. (Mail) 217 N. Almon St., Moscow, Idaho.

Archie A. Langley, assistant terracer, Soil Erosion Service, U. S. Department of Agriculture. (Mail) Hertzog Apartments, Spartanburg, S. C.

Stephen J. Mech, junior agricultural engineer, Soil Erosion Service, U. S. Department of Agriculture. (Mail) Lindale, Tex.

George C. Merkel, junior agricultural engineer, Soil Erosion Service, U. S. Department of Agriculture. (Mail) 1235 S. 15th St., Bethany, Mo.

R. L. Mohler, staff member, Soil Erosion Service, U. S. Department of Agriculture. (Mail) Box 882, High Point, N. C.

Dwight D. Smith, assistant agricultural engineer, Soil Erosion Service, U. S. Department of Agriculture. (Mail) Bethany, Mo.

Clark P. Spellman, director, rural service, Virginia Electric & Power Company, Richmond, Va. (Mail) Box 1194.

William R. Stanley, engineer, Soil Erosion Service, U. S. Department of Agriculture. (Mail) Mankato, Kans.

H. Russell Tribou, junior agricultural engineer, Soil Erosion Service, U. S. Department of Agriculture. (Mail) Box 882, High Point, N. C.

TRANSFER OF GRADE

Ralph W. Baird, associate agricultural engineer, Soil Erosion Service, U. S. Department of Agriculture. (Mail) Box 403, Tyler, Texas. (Junior to Associate Member)

H. F. McColly, head, department of agricultural engineering, North Dakota Agricultural College, Fargo, N. D. (Associate Member to Member)

Applicants for Membership

The following is a list of applicants for membership in the American Society of Agricultural Engineers received since the publication of the May issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Dwight L. Chapman, junior agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) Box 163, Temple, Tex.

Henry A. Dyer, assistant agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) Box 250, Spartanburg, S. C.

A. T. Easton, administrator in charge, Soil Conservation Service, U. S. Department of Agriculture. (Mail) 71 West Fourth St., Chillicothe, Ohio.

A. P. Eves, agricultural consultation engineer, 3445 Kenilworth Ave., Berwyn, Ill.

Glenn F. Hoover, soil erosion engineer, Cleveland Tractor Co., 19300 Euclid Ave., Cleveland, Ohio.

William X. Hull, district supervising engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) Spartanburg, S. C.

Paul Jacobson, assistant agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) 402 Crose Court, Shenandoah, Iowa.

D. D. Lee, associate professor of agricultural engineering, Clemson Agricultural College, Clemson, S. C.

H. H. Lester, supervising engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) Box 71, Meridan, Miss.

Marshall L. Noel, assistant industrial sales manager, Allis-Chalmers Mfg. Co., Milwaukee, Wis.

Frederick A. Olmstead, vice-president, The Chain Products Co., 3924 Cooper Ave., Cleveland, Ohio.

J. E. Reid, sales work, J. I. Case Co., 700 State St., Racine, Wis.

Lionel C. Tschudy, district supervising engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) La Crosse, Wis.

Frank L. Yohe, camp engineer, Iowa ECW, Soil Conservation Service, U. S. Department of Agriculture. (Mail) Lamoni, Iowa.

TRANSFER OF GRADE

O. W. Howe, instructor in agricultural engineering, University of Minnesota. (Mail) 1388 Raymond Ave., St. Paul, Minn. (Junior to Associate Member.)

STUDENT ACTIVITIES

Contributed and edited by members of ASAE student branches

News of Illinois Branch

THE STUDENT Branch at the University of Illinois is rather small since we have only a few students taking the straight agricultural engineering curriculum at present, but we have many more interested in various phases of the subject. We had twelve members at the beginning of the school year and three new members were added during the year. Three of our members graduated in February and two more will leave us this summer.

The officers for the first term were president, W. D. Rusk; vice-president, C. W. Ramsey; secretary and treasurer, W. S. McKown. The first meeting of the Branch was held October 9 and President Rusk told the Branch of its connection with the ASAE and of the qualifications necessary to become a member. He also spoke of the new policy of the Society in requesting a monthly report from each Branch. Professor E. W. Lehmann, head of the department of agricultural engineering, gave the Branch a short talk on the aim of the agricultural engineering society and the advantages of making contacts with other members.

We have had several interesting speakers this year. As it is the aim of the Branch to have a speaker on every phase that may be of interest to members, we have had the following:

Professor R. I. Shawl of our agricultural engineering department talked on the quality of lubricants, telling how oils were tested, kinds of oils, specifications, and of the experience with cheap oils.

Mr. M. G. Hoagland, of the Illinois Power and Light Company, talked on rural electrification, pointing out the possibilities in this field and the advantages to the farmer.

Mr. H. R. Murphy, of the Caterpillar Tractor Company, spoke on terraces and terracing machinery. He pointed out that erosion control is needed upon some 100 million acres in the United States.

Mr. A. W. Farrall, of the Creamery Package Mfg. Co., talked on the engineering features in milk handling, emphasizing the increasing of vitamin D content by ultra-violet ray light.

Mr. R. H. Reed, of our agricultural engineering department, talked on his research work on apple washing machinery, another new field for the engineer.

Mr. C. H. Everett, of the Doane Agricultural Service, talked on engineering features of agricultural appraisals and appraisal reports.

Mr. Thayer Cleaver, of the USDA Bureau of Agricultural Engineering, talked on the problem of good plowing. Good trash coverage is essential in the control of plant diseases and insects.

A meeting was called for the election of officers for the second term on March 12, and the following were elected: President, R. A. Duncan; vice-president, H. M. Marlow; secretary and treasurer, H. Myers.

Farm and Home Week held January 14 to 18 gave the Branch an opportunity to earn some extra money. The members were organized and a stand was set up in the machine laboratory of the agricultural engineering building. Hot sandwiches, coffee, milk, pie, and ice cream were served. The net profit was $31.32. This money is used by the Branch to pay its various expenses.

The committee on program for engineering open house asked the agricultural engineering department to cooperate and help out with the exhibit. This was the first time for us to join in this all day and evening exhibit. With the aid of Professor Lehmann and others of the department the following program was worked out:

1 Exhibit and demonstration of soil erosion control and water conservation
2 A display of blueprints, charts, photographs, and bulletins on farm building and housing improvement.
3 Some agricultural engineering developments in rural electrification, illustrated by charts and exhibits.
4 Power and machinery display, including Diesel tractor and terracer and other special machines.—Hubert Myers, secretary and treasurer.

Penn State News

THE PENN STATE Branch, the agricultural engineering faculty, and representatives of the local power company, as guests of the Penn Central Light and Power Company, of Altoona, made an inspection trip through the company's territory and power plants on Saturday, May 11. Six Penn Central representatives accompanying a chartered bus met the group at the campus at 8:00 a.m. to begin the 200-mile trip.

At the first stop the group inspected the Warriors Ridge hydro-electric plant. Many interesting features of the plant were explained, including the silting of the dam by soil erosion on the watershed. Following luncheon the group proceeded to the Saxton steam-electric plant and was taken through the plant in parties of six, each being provided with a guide. The remainder of the afternoon was spent visiting a milk-receiving station and an electrically equipped poultry farm.

The day was concluded by a dinner at the Penn Alto Hotel in Altoona. Brief talks were given by Mr. W. H. Wade, vice-president and general manager of the company, and Mr. C. L. East, rural service manager. James Baker, retiring president, and Robert Curry, president-elect of the Branch, responded for the group. Mr. W. H. Wade accepted honorary membership in the Student Branch, which was offered him due to his active interest in the group.

Six evening meetings were held during the second semester. Outside speakers were present at two of the meetings; two were business meetings, and members of the faculty and students spoke at the others. Guest speakers were Mr. R. W. Sohl, of the Goodyear Tire and Rubber Company, and Mr. W. F. Barnard, of the International Harvester Company.

The Branch participated in the annual ag student faculty get-together by constructing and operating an amusement device termed "the electric fortune teller." It consisted of a series of thermocouples in a hand grip which when grasped caused a beam of light to be deflected on a scale. Portions of the scale were marked to signify different traits, thus indicating one's "fortune." A rheostat control assisted in magnifying certain of the temperatures and added to the merriment.—Rees Brower, secretary-treasurer.

Report of Georgia Branch

THE GEORGIA Student Branch of the ASAE had 24 members out of 29 students eligible for membership the first term, and 22 out of 24 students eligible the second term. Eight members graduate this spring.

The Georgia "Ag. Engineer," a 54-page annual 2000 copies strong, was published by the Branch. The Branch sponsored a sound picture in cooperation with the Chevrolet Motor Company for all students and the public. Mr. H. C. Seaton and Mr. M. R. Seaton were awarded honor keys for outstanding work done in the Branch.

The Branch assisted in the machinery and terracing demonstrations at the Livestock and Legume Day, with 2500 visitors present. The farm shop contest for vocational high school students at the Macon Fair was carried out with the help of the members. The Branch's baseball team was league champion 1934-1935.

The members of the Branch gave a dance for all college of agriculture students and a banquet for the seniors.

Outstanding speakers during the year have included R. U. Blasingame, Pennsylvania State College; Paul W. Chapman, dean of agriculture, University of Georgia; Loy E. Rast, head of SES project 19; H. A. Van Heistma, Boeing School of Aeronautics; U. H. Davenport, associate professor of agricultural engineering, University of Georgia; G. A. Crabb, head, soils department SES project 19; Mr. Carlson, International Harvester Co.; W. N. Danner, Jr., associate professor of agricultural engineering, University of Georgia; Frank E. Mitchell, professor of poultry, University of Georgia, and W. E. Conklin, architect.

Virginia Branch Reports

THE BRANCH at Virginia Polytechnic Institute will complete the activities of a very successful season at a smoker to be held on the night of May 23. Regular meetings have been held every Thursday night during the year with the exception of those Thursdays during examination periods and holidays. Much interest has been shown by the members of the Branch this year as was indicated by the attendance at meetings and the fine talks that the members have given at the regular meetings.

There are twenty members of the Branch at this institution. They include, with one or two exceptions, all of the seniors, juniors and sophomores in the school who are enrolled in agricultural engineering. Of this number, nine will graduate this spring. We regret the loss of our president, W. B. Grizzard, by graduation this spring, as well as other seniors, who like him have taken such an active part in the activities of the organization this year.

Our regular meetings have consisted chiefly of talks by the members. These talks

were on subjects concerning agricultural engineering, or on some agricultural or technical subject. Outside speakers have addressed the Branch on several occasions during the year. The meetings have been open to other students, at some of these addresses, so that they too might enjoy the talks. The branch sponsored a moving picture show during the fall quarter in which the importance of soil erosion control was shown by showing scenes of great waste by erosion.

The new officers for our Branch were recently elected. They are: J. J. Bass, president; J. B. Burges, vice-president; G. C. Vaughn, secretary and treasurer, and W. B. Hutcheson, scribe. These officers were installed May 3. Officers are elected once each year.—W. B. L. Hutcheson, scribe.

The Missouri Branch

THE MISSOURI Branch began the academic year 1934-35 with twelve members. No new members were added during the year. Out of this group two of the members expect to graduate this spring.

During the first semester the meetings were held jointly with a one-hour seminar class. At each meeting one member of the group would be called upon to give a report on some phase of agricultural engineering of which he had made a study. These meetings were very interesting and of much value. During one of the regular meetings the Branch went on its annual picnic.

The second semester, in addition to a few scientific reports, the activity of the Branch was somewhat varied. At one of the meetings, Professor Wooley entertained the Branch at his home. Mr. Mullen, technician for the ECW camps in Missouri, was present and gave a talk on camp activities and work which was being carried on. His talk was illustrated with pictures which he had taken in the camps. At another regular meeting the Branch entertained the agricultural education club with motion picture films of terracing machinery.

The Branch participated in the engineers' industrial exhibit and also in the agricultural college farmers' fair, both of which are annual events at the University of Missouri. They have also been instrumental in securing individual prizes for winners in the shop contests for vocational agricultural students held on May 1 in connection with the farmers' fair. On May 14 a banquet was held. Mr. R. W. Trullinger, of the U. S. Department of Agriculture, was present and delivered the main address of the evening. It is hoped that this may become an annual affair in the activities of this Branch.—Robert Beasley, scribe.

Minnesota Branch News

THE MINNESOTA Branch at the present time has 17 members which is four less than last fall. Three of the members have graduated and one was unable to return to school. These four men all have jobs. The organization regrets to report the loss of four outstanding members through graduation this spring. We are happy to report that all have good prospects of work.

Several interesting meetings were held during the year. For the first meeting, Mr. S. H. McCrory, chief, Bureau of Agricultural Engineering, USDA, talked on the different fields of work of the bureau.

Another meeting of considerable importance was the joint meeting with the senior group known as the "Minnesota Agricultural Engineers." At this meeting the students presented a skit depicting the studies and curriculum followed by the students of engineering. After the meeting an enjoyable social gathering was held. Mr. C. E. Woodward, editor of the Northwest Farm Equipment Journal, spoke on advertising and engineering.

At another regular meeting, Mr. F. C. Carrol, of the John Deere Co., spoke on farm implement sales.

Besides regular meetings, three business meetings were held, one of which was for the election of officers.

At the time this is being written, the students are busy preparing for Engineers' Field Day, an annual function of the engineering school, in honor of their patron saint, St. Patrick, who it is said invented the first "worm drive." Each year the different branches of engineering have a float in the gala parade, and an open house exhibit.

One of the big undertakings of the organization is to obtain the backing and financial assistance of the University in sending to each high school graduate indicating a preference for engineering, a bulletin similar to the one, entitled "Agricultural Engineering: What It Offers the Young Engineer as a Professional Career."

News from Texas Branch

THE TEXAS Student Branch gave a banquet March 1 in the mess hall for Professor R. U. Blasingame of Pennsylvania State College, after which Professor Blasingame gave an interesting lecture illustrated by lantern slides on "The Adaptation of Power Machinery to Pennsylvania Conditions."

On March 30 the Branch held a barnyard frolic on the third floor of the agricultural engineering building. Prizes were given for the best costumes of boys, girls, and couples. The music was furnished by the Aggieland Orchestra. The frolic was a complete success in every way and received a most favorable report from the commandant's office.

On April 12 and 13, the senior members of the Branch took a two-day inspection trip to the soil erosion service project at Lindale, Texas, which was interesting as well as instructive. On April 16 and 17, the senior members took another two-day inspection to the Blackland Experiment Station and the soil erosion service project at Temple, Texas. They were also guests at a dinner at the Kyle Hotel given the former A. and M. College students.

On May 11 the Branch and the staff of the agricultural engineering department held their annual open house from 10:00 a.m. to 8:00 p.m. This included a large display of farm machinery, twenty automobiles, radios, and refrigerators. Also a display of sixteen old books on agricultural engineering subjects, whose total age was 3925 years.

Ohio Branch Year

ON OCTOBER 11, 1934, a nucleus of twelve members assembled in Ives Hall on the Ohio State University Campus to discuss their experiences of the previous summer and plan what the ASAE Branch at Ohio State would attempt for the coming year. It was decided that the opening gun would be fired by having an open house meeting on October 25 with plenty of cider and doughnuts, and thus it was advertised. Incidentally, it worked. Inasmuch as a detailed report of that meeting appeared in these columns in the November AGRICULTURAL ENGINEERING, I will not elaborate further than to say it was highly successful.

To save time, the happenings at our Branch for the remainder of the 1934-35 school year will be briefly itemized:

November 8—Address by J. S. Cutler, regional director of SES.

November 22—Business meeting to plan programs.

December 13—Talk by S. E. Hill, former CCC foreman and agricultural engineering major student, and moving picture by the John Deere Tractor Co.

January 10—Business meeting to plan for Farmers' Week lunch room.

January 23—Business meeting to discuss Farmers' Week lunch room.

February 7—Special meeting for report on Farmers' Week lunch room. Branch made a net profit of $212.

February 14—Open House.

February 21—Special meeting to accept invitation to visit the Akron plant of Goodyear Tire & Rubber Co., and make plans for the trip.

March 1—75 members and affiliates of the Branch made an all-day visit of the rubber factory and Zeppelin dock.

April 4—Business meeting to make nominations of officers for coming year.

April 11—Renominations were made due to a slight irregularity in previous meeting. Entertainment for winners in year's membership contest, which was increased from 12 to 49.

April 25—Report of election and plans for spring banquet.

May 9—Six student delegates selected to represent O.S.U. at ASAE annual meeting at Athens, June 17 to 20.

May 23—Spring banquet and installation of new officers.—Chas. Schlotterbeck, scribe.

From the Kansas Branch

WE HAD twenty members during the fall semester, and this spring semester we have twenty-five members. Two of our group complete their work this spring, Victor Hopeman and Roy D. Crist.

At the regular meetings short talks were given by the seniors, each senior being required to give a talk sometime during the semester. Professors Fenton and Zink gave a report of their trip to the ASAE divisions meeting at Chicago in December.

At another of the meetings, June Roberts gave a talk on steel resistance to soil abrasion. Mr. Roberts is filling the vacancy in the faculty caused by Professor Logan's leave of absence. He has built a wear-testing machine and has done a good deal of testing during the past year.

The spring semester was devoted to talks by the juniors, each junior being required to give a talk sometime during the semester. At one meeting Professor C. A. Logan, who is now at Mankato with the soil erosion work, gave an illustrated report of their work there.

Professor O. E. Hunt, of the electrical engineering department gave a lecture on "Lights and Lighting Effects."

May 9 we had our annual spring picnic in Sunset Park. All members and also all freshmen were invited. We played soft ball after which C. E. McKee, as chairman of the refreshment committee, took charge. Before the meeting adjourned, officers were elected for next year, as follows: C. R. Crawford, president; James Johnson, vice-president; C. E. McKee, secretary, and W. Walker, treasurer.—E. H. Kloepper, scribe.

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ON March 26th of this year Austin-Western went into Missouri with a number 8 Terracer to build the broad base, 38-foot terraces shown in the accompanying illustrations.

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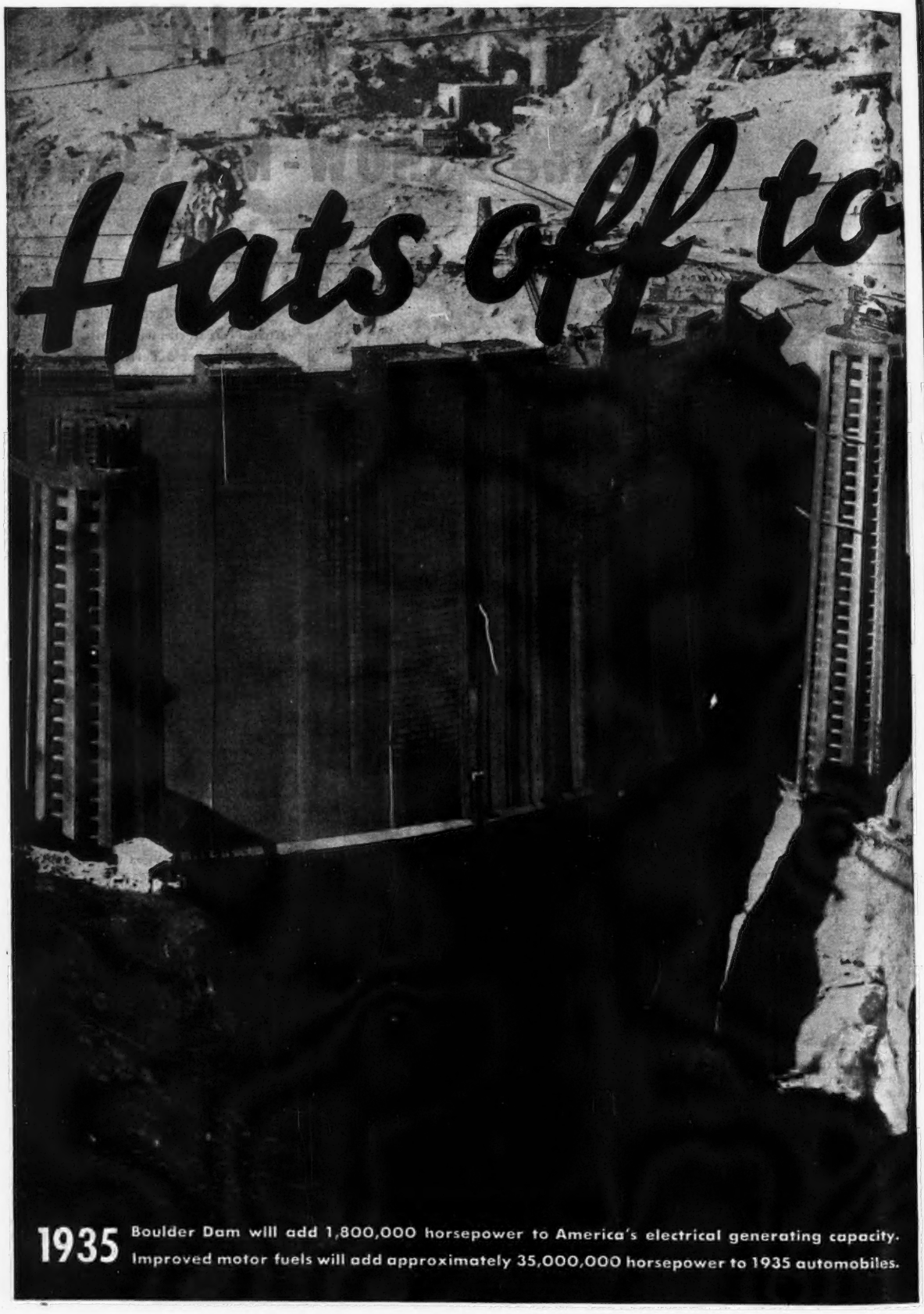
Hats off to
1935 Boulder Dam will add 1,800,000 horsepower to America's electrical generating capacity.
Improved motor fuels will add approximately 35,000,000 horsepower to 1935 automobiles.

Boulder Dam

BUT REMEMBER—

Microscopic changes

in this drop of gasoline

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NINETEEN THIRTY-FIVE will be a great year. Boulder Dam will change the Colorado River from a wasteful and destructive force into a source of 1,800,000 horsepower of beneficent electrical energy. This great engineering achievement, containing more concrete than all the other dams in this country combined, would alone make 1935 a year to be remembered in the history of American engineering. But also in the same year—over three million new automobiles will be manufactured, with a total capacity of over 250,000,000 horsepower.

And more than 35,000,000 horsepower of this total will be contributed by advances in engine design made possible by the improved motor fuel available today. With the gasoline of 10 years ago, these millions of potential horsepower were wasted . . . as the potential power of the Colorado River was wasted for generations. The average brake mean effective pressure of American automobiles has increased 40% in ten years. Each cubic inch of engine displacement now yields 70% more power than it did in 1925.

The *additional* power of 1935 cars due to improved fuels alone is not only much greater than the capacity of Boulder Dam; it is greater than the total water power capacity of the country. Thirty-five million additional horsepower added to 1935 cars because oil and automotive engineers worked together to squeeze more power out of each drop of gasoline! That, too, is a rare achievement.

The Ethyl Gasoline Corporation is proud that its research facilities have played a part in this cooperative progress. It is our hope that we may also cooperate in the progress that is certain to come in the next ten years. And for this purpose we offer our services to oil and automotive companies in whatever ways they may prove valuable, whether or not the problems are directly connected with the anti-knock quality of gasoline. We invite you to call upon us.

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(Continued from page 229)

MACHINERY FOR DUSTING COTTON, *R. C. Gaines* and *D. A. Isler*. U. S. Dept. Agr., Farmers' Bul. 1729 (1934), pp. II + 14, figs. 11. This bulletin supersedes Farmers' Bulletin No. 1319. It gives practical information on the selection of cotton dusting machinery best suited to the needs and conditions of individual farms.

THE PRINCIPLE OF ELECTRIC WELDING, *R. C. Stockton*. London: Isaac Pitman & Sons, 1933, pp. VII + 184 + 23, figs. 73. This handbook contains chapters on thermal and other methods of joining metals, properties of metals, metallic arc welding, examples of welding practice, testing welded work and welding materials, and electrical notes.

POTATO LOSSES IN HANDLING REDUCED BY SIMPLE EQUIPMENT, *A. D. Edgar*. U. S. Dept. Agr. Yearbook 1934, pp. 292-296, figs. 3. A brief summary of the results of experiments conducted by the Bureau of Agricultural Engineering is presented, indicating that mechanical diggers cause fewer injuries to potatoes than digging by hand.

Digger injuries can be reduced by running the continuous-elevator type of digger low at the rear end, and by padding the tines and projections of the shaker-elevator type of digger. Picking potatoes into baskets of the split-wood variety causes less injury than picking them into metal baskets.

The average grader injury of about 2 per cent may be reduced by padding ramps between runs of conveyor belt and grading chain, and such corners as the moving potatoes might hit. Keeping the grader in adjustment and repair is equally important in preventing grader injury.

In all steps in the handling, it has been found, the temperature of the potatoes affects the amount of injury suffered. If the potatoes have a temperature of 50 deg F, or above, appreciably less bruising results than when they are handled at lower temperatures. In a storage house one bin may be warmed without affecting the others by blowing warm air from the main alley into the conveyor or trench of the bin to be warmed.

IRRIGATION OF WEEDS AND OTHER NON-CROP PLANTS COSTLY AND UNPROFITABLE, *O. V. P. Stout*. U. S. Dept. Agr. Yearbook 1934, pp. 250-253. A brief summary is presented of studies conducted by the Bureau of Agricultural Engineering indicating that in general weeds use more water in proportion to the ground actually occupied than does the general run of crops.

HORSES AND MULES MEET NEED FOR CHEAP FLEXIBLE FARM POWER, STUDIES SHOW, *J. O. Williams* and *S. R. Speelman*. U. S. Dept. Agr. Yearbook 1934, pp. 244-247, fig. 1. A brief summary of farm power survey data obtained in several middle western and middle southern states is presented, indicating the flexibility and adaptability of various horse and mule hitches, irrespective of the size, shape, or topography of fields, or soil type, and regardless of whether tillage practices call for speedy or slow work.

SOIL-EROSION STUDIES SHOW VEGETATION HAS DOMINANT ROLE, *H. H. Bennett*. U. S. Dept. Agr. Yearbook, 1934, pp. 322-327, figs. 3. Data secured by the Bureau of Chemistry and Soils from various sources are summarized, showing that vegetation in the form of forest or in thick grasslike growth is an inexpensive, permanent cure for erosion. In one form or another it can be used on all kinds of land, on any degree of slope, and under all varieties of climate where there is heat and rain enough to make plants grow.

TERRACES EFFECTIVE FOR CONTROLLING EROSION ON CULTIVATED LAND, *C. E. Ramser*. U. S. Dept. Agr. Yearbook 1934, pp. 346-348, figs. 3. The results of experiments by the Bureau of Agricultural Engineering are briefly summarized indicating the effectiveness of proper terracing in controlling sheet erosion. Terraces are equally effective in controlling and preventing the development of gullies. It has been observed that terracing generally improves fields for the operation of farm machinery by making the ground surface smoother.

PROBLEMS IN HEATING THE WASH WATER IN APPLE WASHING MACHINES, *A. H. Reed*. Ill. State Hort. Soc. Trans., 67 (1933), pp. 276-292, figs. 2. In a contribution from the Illinois Experiment Station the methods of operating the various systems of heating wash water are described and their advantages and disadvantages discussed.

CENTRIFUGAL PUMPS, TURBINES, AND PROPELLERS, *W. Spannhake*. Cambridge: Mass. Inst. Tech., 1934, pp. XIV + 328, figs. 182. This is a translation from the German by J. B. Drisko. It is a comprehensive treatment of the fluid mechanics of rotary hydraulic machinery. It is divided into sections relating to the essentials of hydromechanics, the full-admission turbo-runner in inclosed flow, full-admission turbo-runners in uninclosed flow, and the modern impulse turbine, and contains chapters on the properties of ideal, constant-volume fluids—fundamental concepts and definitions; the characteristic types of motion of flowing fluids, with descriptions; dynamics of ideal fluids; viscous liquids; forces acting and exchange of energy between flowing fluids and still or moving rigid bodies; description of the full-admission runner in inclosed flow and its field of flow; forces acting and exchange of energy in the full-admission turbo-runner in inclosed flow; similitude relations and type series of turbo-machines; supplement to the basic theory of full-admission turbo-runners in inclosed flow; jet theory of axial runners in uninclosed flow; and undimensional theory of the Pelton turbine.

A NEW TYPE WINNOWING MACHINE FOR THE SEPARATION OF GRAIN AND BHOOSA, *T. A. M. Brownlie*. Agr. and Livestock in India. 4 (1934), no. 1, pp. 29-35, pls. 2. This machine is described and illustrated and the tests forming the basis of its development are reported. The tests definitely showed that owing to the lightness and flaky nature of bhoosa the simplest method of separation from the grain was by allowing the mixture a perfectly free fall in a continuous stream of definite width and trifling thickness and by passing a current of air through this falling curtain of the material.

Tests with air currents from 9 to 20 miles per hour indicated that the grain-bhoosa mixture could not be satisfactorily separated when falling through an air current of less than 4.5 ft diameter, and the most satisfactory and economical results were obtained with an air current of 5 ft diameter and a wind velocity between 11 and 16 miles per hour.

To meet these requirements a blower of the impeller type was adopted, this constituting a new development in winnower design.

The resulting machine comprises a steel frame on which is mounted a six-blade fan of the impeller type, 5 ft in diameter, discharging 25,000 cu ft of air per minute at a velocity of 14 miles per hour and having an efficiency of over 90 per cent. Surrounding the fan and carried on three rollers of the drum type is a conveyor of the flexible ladder and scraper bucket type. The buckets, or scrapers, carry the grain-bhooza mixture up a nearly vertical guide plane and hence over a horizontal distribution platform above the fan. The horizontal distribution platform is cut away at an angle to its length, thus permitting the contents of each bucket to discharge gradually over the entire length of the cut on to a shoot in front of the fan. Thus a continuous stream of the grain-bhoosa mixture in the form of a curtain of width less than the diameter of the fan and thickness just over one inch falls into the air current and at right angles to that current.

TESTS ON NAILED JOINTS PROVIDE DATA ON STRENGTH, *J. B. Wells*. Engin. News-Rec., 113 (1934), no. 13, pp. 391, 392, figs. 3. Tests conducted at Stanford University to measure deformation and ultimate strength in about 175 various nailed joints are reported. All lumber used was Douglas fir. All joints were made up with lumber of ordinary sizes and were nailed with common wire nails excepting that in testing plywood, galvanized, cement-coated, and barbed nails were used in addition to the common variety. Each joint was constructed of three pieces, a thick central block with a thinner piece nailed on each side. All nails were in single shear.

The data is presented graphically but no conclusions are drawn.

ASPHALT CONCRETE FOR FLOOR CONSTRUCTION, *C. H. Jefferson*. Michigan Sta. Quart. Bul., 17 (1934), no. 1, pp. 3-9, figs. 7. Practical information is given on the use of asphalt concrete for the construction of floors in farm buildings.

THE EVOLVING HOUSE—I. A HISTORY OF THE HOME, *A. F. Bemis* and *J. Burchard* 2nd. Cambridge: Mass. Inst. Technol., 1933. pp. XXXI + 502, figs. 152. This is the first of a series of three volumes dealing with the fundamental features of housing. It presents the history of the home to provide a background to housing development. It includes three parts relating to prehistoric and primitive homes, evolution of the modern American home, and modern homes of the world. *(Continued on page 242)*

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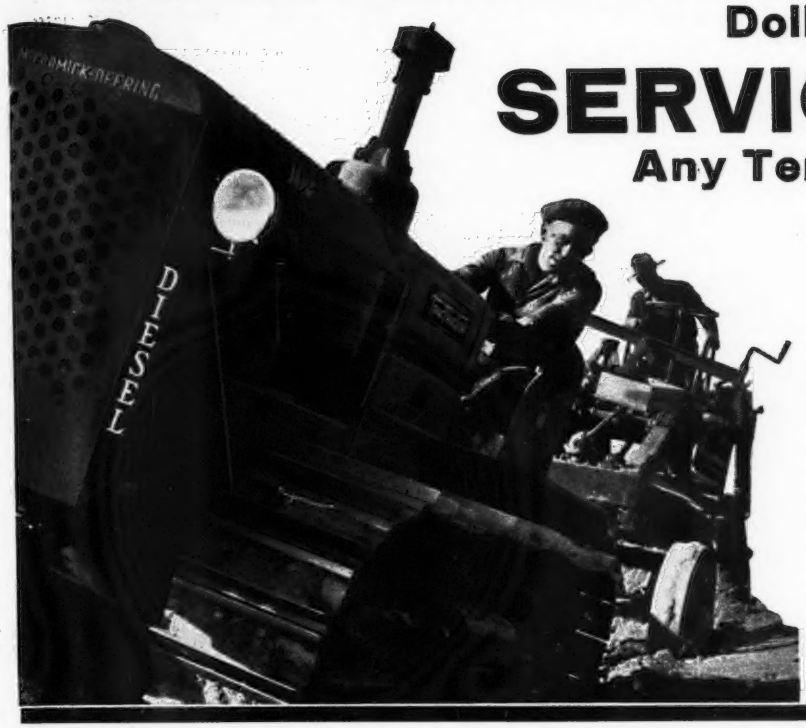

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These are some of the reasons why the McCormick-Deering Diesel TracTracTor is fitting so well into cooperative and governmental terracing projects all over the country. Big things are being done with this powerful, accessible crawler . . . . and, because it is the approved size for the job, the cost sheets look mighty satisfactory when the job is finished.

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Agricultural Engineering Digest

(Continued from page 238)

BRICK LINING USED FOR IRRIGATION CANAL IN TEXAS, *W. I. Gilson.* Engin. News-Rec., 113 (1934), no. 8, pp. 246, 247, figs. 3. An account is given of the lining of an experimental 500-ft section of irrigation canal.

The cost data indicate that the cost per square foot for this lining is less than for most types of concrete linings. No equipment is required for this lining installation other than simple devices which any intelligent foreman can make. Observations to date indicate that there is less cracking resulting from setting and temperature changes than in some forms of concrete lining. The semicircular section provides desirable hydraulic characteristics.

LUBRICATING OIL TEST, *J. I. Clower.* (Va. Polytech. Inst. Bul. 27 (1934), no. 11, pt. 2, pp. 41, figs. 15. This is a practical interpretation of the significance of the chemical, physical, and mechanical tests commonly applied to lubricating oils.

SPARK ARRESTERS FOR MOTORIZED EQUIPMENT, *J. P. Fairbank* and *R. Bainer.* California Sta. Bul. 577 (1934), pp. 42, figs. 22. The results of a large number of field and laboratory studies are reported. Equipment devised for heating carbon to known temperatures and quickly ejecting it into vegetation to determine the sizes and temperatures necessary to start fires is described. A 2.5-kw, high-temperature, combustion tube furnace rated at working temperatures up to 2500 deg F was used for heating the carbon particles. Current was supplied by an engine-generator set mounted on a truck, and the temperature was controlled by voltage regulation. Five classifications of carbon sizes were used. The basis for segregation was a set of Tyler square-mesh screens in which the diameter of each succeeding opening was one-half that of the one preceding. The sizes of openings through which the carbon particles numbered 1 to 5 would pass were 0.371, 0.185, 0.093, 0.046, and 0.023 in.

It was found that the amount of carbon ejected with the exhaust gas for the average tractor engine varies from less than 0.1 to 1.0 g per hour, according to the condition of the engine. On the average, 50 per cent of this carbon is of a size that will not pass a 28-mesh, or Size 5, screen. Since the kindling temperature for this carbon varied from 887 deg for Size 5 to 1022 deg for Size 2, evidently carbon can be ignited by the temperatures existing in the exhaust system of an internal-combustion engine.

Fires can be consistently started in dry vegetation by carbon particles, Sizes 1, 2, and 3, with initial temperatures of 1500 to 1600 deg during the normal summer conditions in California. In extremely warm dry weather fires may be started with these sizes at temperatures as low as 1300 deg.

Fires can be started by Size 4 with an initial temperature of 1500 deg under conditions favorable to fire.

Carbon Size 5, when heated to an initial temperature of 1500 deg, can start a fire in dry grass on extremely hot dry days. This size of particle, however, lost its heat so rapidly that it ceased to glow within a distance of 9 ft from the furnace when heated to an initial temperature of 1800 deg. In practice, therefore, the exhaust pipe could be turned up, discharging into the air, thus providing the necessary distance for cooling the smaller particles before they reach the ground.

The tendency for brush-field and pine-needle litter to be ignited by carbon sparks is about the same. Both catch fire less easily than dry grass. Punk, however, was found not only to be readily ignited but to cause hang fires; that is, the material did not blaze immediately but continued to smoulder and finally burst into flame. In one case the time was 40 min.

Exhaust pipes having surface temperatures of 1200 deg may start fires upon contact with dry grass. Surfaces with temperatures as low as 838 deg may ignite dry vegetation after several minutes of contact, which could occur if dry grass or straw lodged on an exhaust manifold. If the surface shows even the slightest red color when viewed at night it is dangerous, and the part should be so placed or guarded that it will not touch vegetation.

Several commercial spark arresters now on the market were above 95 per cent in efficiency in stopping carbon Sizes 2 and 3, but all were 80 per cent or below in efficiency for Size 4. One commercial arrester was below 20 per cent in efficiency for all sizes of carbon. The efficiency of one arrester was increased from 69.3 to 97.6 per cent for Size 4 carbon by a slight modification in design. One experimental arrester had an efficiency of 93 per cent or higher for carbon Sizes 2, 3, and 4. The arresters with the highest efficiency created the least back pressure on the exhaust system. The average muffler cannot be considered a satisfactory spark arrester. No doubt it assists somewhat, especially in the cooling of particles.

Iron screen over the exhaust pipe presents considerable danger, as holes may burn through without the operator's knowledge, thus presenting a fire hazard from an unprotected exhaust system until replaced. Alloy screens consisting of 80 per cent nickel and 20 per cent chromium stood up much better than iron screen. The cheaper grades of these alloy screens, however, contain varying amounts of iron and are therefore unsuitable for this type of apparatus.

THE SILT PROBLEM, *J. C. Stevens.* Amer. Soc. Civ. Engin. Proc., 60 (1934), no. 8, pt. 1, pp. 1179-1222, figs. 9. This paper presents data on the silting of reservoirs obtained from actual capacity surveys, and discusses remedial measures for silt elimination. A table contains a brief of all data on the silt transported by the streams of the world. The physical laws of silt transportation are outlined, with pertinent discussion. The control of silt in canals, reservoirs, and on watersheds is then considered. The paper closes with data and discussion on the origin of silt.

DEVELOPMENT OF DAIRY MACHINERY, *H. J. Hopfen.* [Internatl. Rev. Agr.] Mo. Bul. Agr. Sci. and Pract. [Roma], 25 (1934), no. 4, pp. 161-165. Data are presented and discussed on the manufacture, export, and import of dairy machinery, including cream separators especially in the various countries of the world during the years 1928-32.

A STUDY OF THE PROPERTIES OF MORTARS AND BRICKS AND THEIR RELATION TO BOND, *L. A. Palmer* and *D. A. Parsons.* [U. S.] Bur. Standards Jour. Res., 12 (1934), no. 5, pp. 609-644, figs. 17. The water-retaining capacity, transverse and compressive strengths, sorption, volume changes, and moduli of elasticity of 50 mortars and the absorption rate, moisture expansion, and transverse and compressive strengths of six makes of brick were studied. Also, 15 of the 50 mortars were used with the six makes of brick in tests of brick-mortar assemblages.

It was found that the extent of bond was affected by the properties of both mortars and bricks, but chiefly by the water-retaining capacities of the mortars and the absorption rates of the bricks. With bricks of high rates of absorption set dry, the extent and in most cases the strength of bond was best with mortars of high water-retaining capacity. Although the extent of bond was good (practically complete), the strength of bond obtained with very impervious bricks having smooth, glassy, bonding surfaces was generally lower than that obtained with the other makes of bricks. Rough-surfaced bricks with low rates of absorption, and mechanically smooth and porous bricks made practically non-absorptive by soaking in water gave good extent of bond when time in brick laying was not permitted for the water in mortars of low water-retaining capacity to separate out. When such time was allowed the extent of bond was poor with the mortars of low water-retaining capacity. The maximum bond strength at 3 mo was obtained in the case of all mortars with bricks having a rate of absorption of approximately 20 gm of water per 30 sq in of brick surface per minute when partially immersed (flat side down) to a depth of $\frac{1}{8}$ in in water. The bond with mortars of low sorption and high strength was most resistant to alternate freezing and thawing.

It is indicated that best results may be generally obtained by keeping the rate of absorption of bricks below the value 40 gm of water, as obtained by partial immersion (flat side down) for 1 min in water.

THE BENDING OF WOOD, *T. R. C. Wilson.* U. S. Dept. Agr., Forest Serv., Forest Prod. Lab., 1933, pp. 12, figs. 3; also in Wood Prod., 11 (1933), nos. 10, pp. 11, 12, figs. 3; 11, pp. 13, 14, 16, figs. 5; 12, pp. 13, 14, figs. 2. Technical information is presented on the process of bending wood for various purposes.

PAINTING EXTERIOR WOODWORK, *F. L. Browne.* U. S. Dept. Agr., Forest Serv., Forest Prod. Lab. (1934), pp. 5, pls. 2. Practical information on the subject is presented briefly.

FARMHOUSE PLANS, *W. Ashby.* U. S. Dept. Agr., Farmers' Bul. 1738 (1934), pp. II + 70, figs. 40. The farmhouse plans presented in this bulletin were developed in connection with the Farm Housing Survey made in the spring of 1934 by the Department and the agricultural colleges of 46 states with funds provided by the Civil Works Administration. *(Continued on page 244)*

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Agricultural Engineering Digest

(Continued from page 242)

PLYWOOD AS A STRUCTURAL COVERING FOR FRAME WALLS AND WALL UNITS, *G. W. Thayer.* U. S. Dept. Agr., Forest Serv., Forest Prod. Lab., 1934, pp. 18, figs. 5. Tests are reported the purpose of which was to determine the extent to which plywood can impart strength and stiffness to a house wall, to show the relation between method of fastening the sheet to the frame and the amount of inherent stiffness and strength utilized, and to secure a measure of the performance of small units offering possibilities from the standpoint of fabrication and assembly. All test panels were 8 ft high by 12 ft long. They were either a single unit of those dimensions or an assembly of three separate units each 8 ft high by 4 ft wide. Those made as a single unit consisted of 2-by-4-in upper and lower plates, 3-piece end posts, and 2-by-4-in studs spaced 16 in. The end posts consisted of two 2-by-4-in pieces spaced ⅜ in, to which a third 2-by-4 was nailed with its 4-in side perpendicular to the 4-in sides of the other two. One of these panels was framed for a double 26-by-28-in window, and two were framed for a double 26-by-28-in window and a 2-ft 8-in by 6-ft 8-in door. Two 16-penny nails were driven through the upper and lower plates into the ends of the studs. The framing material was southern yellow pine, and the plywood which was attached to the frame was of Douglas fir, sanded on two sides, and in sheets 4 by 8 ft.

The results showed that plywood in large sheets, ¼ in or more in thickness, well nailed to a frame wall affords several times the rigidity and strength that is afforded by horizontal sheathing. In this respect it compares favorably with diagonal sheathing. The extent to which the inherent rigidity and strength of large plywood sheets are utilized depends upon the security with which the plywood is attached to the frame. It is entirely possible, for example, to obtain greater rigidity with ¼-in plywood well nailed to the frame than with ⅜-in plywood inadequately nailed. By gluing plywood to the frame a rigidity is obtained that is far superior to anything possible with nailing.

Wall units of convenient size for factory fabrication and facile erection can be assembled with glued splines in such a way that in rigidity and strength they are fully equal to similarly sheathed large wall panels framed in the conventional manner. A design for such units is described in the report.

THE USE OF CREOSOTE AND OTHER TAR OILS AS MOTOR FUELS, *L. J. Rogers.* Jour. Council Sci. and Indus. Res. [Aust.], 6 (1933), no. 1, pp. 47-53. This is a brief survey of the technical aspects of the use of creosote as an internal-combustion-engine fuel and of the economic aspects of the problem as it affects Australia.

FLOOR PANELS WITH STRESSED PLYWOOD COVERINGS. *G. W. Trayer.* U. S. Dept. Agr. Forest Serv., Forest Prod. Lab., 1934, pp. 10, figs. 3. Tests are reported in which panels were used consisting of relatively shallow joists to the top of which plywood suitable for a subfloor was nailed and glued, and to the bottom of which thinner plywood, to serve as a ceiling in lieu of plaster, was also nailed and glued. The panels were tested over a span of 13.5 ft with load applied at the third points.

The results indicate that floor panels made with stressed top and bottom coverings, such as with plywood glued to joists to form a box girder, can be made with satisfactory strength and stiffness. For a panel length of 14 ft a joist height of 5⅜ in appears suitable, which means an appreciable reduction in the thickness of the floor system aside from any consideration of less material and labor costs. In order to obtain sufficient stiffness in panels over 14 ft in length a joist depth greater than 5⅜ in or thicker plywood than that used in the tests would be required, although the former would furnish the added stiffness with less material. The stiffness of floor panels made in the fashion described can be calculated with reasonable accuracy by neglecting the plies of the coverings that run at right angles to the length and by using five-sixths of the modulus of elasticity for the wood of which the plywood is made, based on corresponding moisture content values.

AN EQUIPMENT FOR DEMONSTRATING SOIL EROSION AND ITS CONTROL, *F. G. Merkle.* Jour. Amer. Soc. Agron., 26 (1934), no. 7, pp. 626-628, figs. 2. In a brief contribution from the Pennsylvania Agricultural Experiment Station equipment is described consisting of a rack to hold several erosion trays at any desired slope, trays in which various soils or cover crops may be compared, and carboys to receive the turbid run-off.

The individual trays are 4 in deep, 12 in wide, and 32 in long. A dam with beveled edge is placed 3 in from the lower end, thus providing a place for the surface run-off to collect so that it may be led by means of the rubber tubing into the carboy.

A ¾-in galvanized pipe spans the front of the frame, being held to the uprights with straps. Along this pipe at intervals of 2 ft are spaced Skinner greenhouse nozzles designed to give a very fine spray. Those afford a very uniform distribution of "rain" over all trays.

(Continued on page 246)

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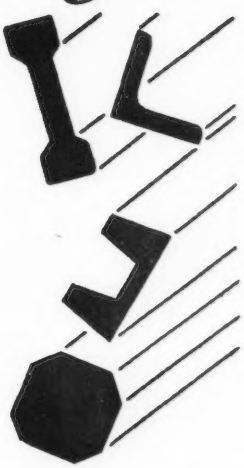

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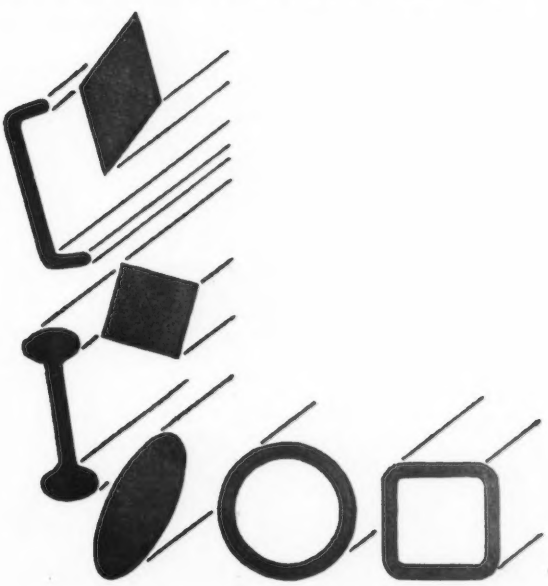

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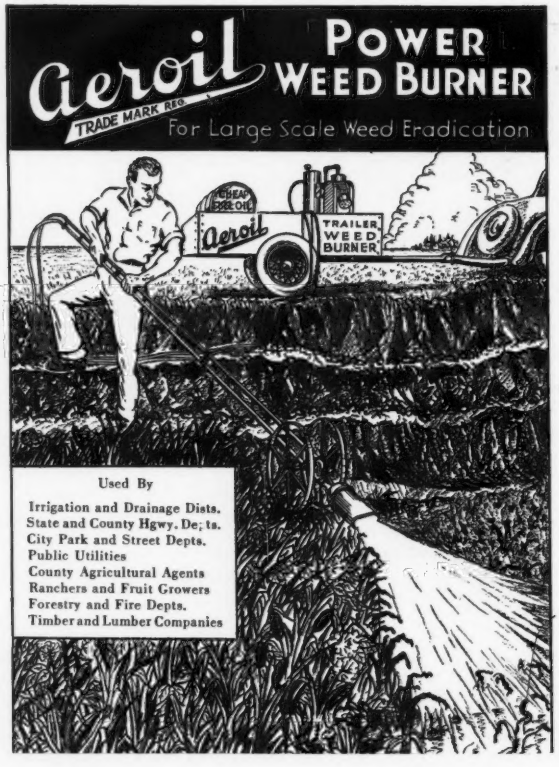

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A New German "Baby" Combine

(Continued from page 228)

machine can go directly into the field and start harvesting in the most favorable direction, which, in lodged grain, is an especial advantage. Also, the machine can cut its full width, as it will not have to travel around the field but can turn at the headlands and travel back and forth across the field. It has the advantage too that while in motion it can dump off the sacks in rows at the edge of the field, which simplifies the gathering of them.

The machine leaves a stubble about 10 cm (4 in) high and can harvest grain of a length from 40 cm (16 in) up to 2 m (78¾ in). The power consumption of the machine running idle is about 4 hp and while working it is 8 to 12 hp, as transmitted by the power take-off of a 15-30 hp tractor. The threshing is in all cases accomplished without difficulty and the losses are practically nil. The threshed grain reaches the sacks in an almost clean condition. The machine, of course, is mounted on the tractor only during harvest time. Mounting and demounting can be accomplished in a very short time. The weight of the machine is approximately 1,400 kg (3080 lb), and the German price is 3,500 R.M.

The handling of the straw, which is of special value in Germany, is accomplished either by a straw binder which works directly behind the machine, or by a pick-up baler. The baler is driven by the power take-off of a standard tractor. It is in a position to bind the straw on about one hectare (2.47 acres) an hour, and the bales are bound with two bands of binder twine.

It is of advantage to furnish a collecting chute on which it is possible to hold 10 to 15 bales, and then set them off from time to time. If the piles of straw are set off in cross rows, a saving of 50 per cent in labor in the loading operation can be made. The power requirement of the baler amounts to between 6 and 8 hp. This outfit has already worked successfully in the County of Norfolk in England. It is also adapted for the stacking of straw.

Agricultural Engineering Digest

(Continued from page 244)

MORTAR TESTS AS A GUIDE TO THE STRENGTH OF CONCRETE. *W. H. Glanville* and *D. A. G. Reid*. Struct. Engin., 12 (1934), no. 5, pp. 242-263, figs. 12. Investigations conducted by the Building Research Experiment Station of the British Department of Scientific and Industrial Research are reported in which the object was to devise a small scale mortar test for use as an index of the strength of concrete made from the same cement.

Preliminary tests showed that standard sand mortar strengths form as good a guide to concrete strength as those with graded sand. It was found that as a general rule the strength of the wet mortar is a greater proportion of the strength of the dry mortar for slow than for rapid-hardening cements. The value of the mortar strengths as a guide to the concrete strengths increases as the consistence of the mortar is made wetter. Neat cement and dry mortar mixes form a very poor guide to the strength of concrete, particularly when the various ages of testing are not considered separately. The best guide to the crushing strength of concrete is given by the crushing strength of mixes of 1:3 standard sand mortar as used under the British Standard Specification for portland cement, but with a water content of 12.5 per cent of water by weight. The results enable the concrete strength at the same age to be estimated in the majority of cases to within 10 per cent.

The best guide to the transverse strength of concrete is given by the transverse strength of wet mixes of 1:3 standard sand mortar, although the tensile strength of these mixes is practically as good. A few tests made with high alumina cements showed that the wet mortar strength may be used as a guide to concrete crushing strength within the same degree of accuracy as may be expected with portland cements. *(Continued on page 248)*

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SOME YEARS AGO a Texas farmer made up his mind to do a sub-soiling job by blasting. He wrote us for advice as to the correct du Pont explosive to use, and as to details of procedure. Our Agricultural Extension Section wrote him a two-page letter giving him the information he asked. Then it added two pages more advising him not to do the job by blasting at all. Analysis showed that for his conditions it would be more economic to use tractor power than explosive power.

In this and following messages du Pont invites the attention of agricultural engineers—not only land reclamation men, but all branches of the profession—to its explosives as a form of power; concentrated, mobile power that calls for a minimum of equipment and can be put to work in a minimum of time. Detonation of dynamite is really the same as combustion of fuel in an engine cylinder; both produce power by expansion of gases. Du Pont believes that choice among these and other forms of power should be a matter of engineering economics, and welcomes the cooperation of all engineers in selecting the best power for every condition.

In particular, du Pont seeks the assistance of agricultural engineers in those many cases where alliance of explosives with other forms of power brings greatest efficiency, whether it be supplementing muscle in digging holes for trees, posts, or poles; aiding teams or tractors in structural excavations; digging or cleaning ditches, straightening streams and draining low spots; or removing rock and stumps that hamper mechanized farming.

Du Pont invites inquiry on all problems involving the possible use of explosives, and to their efficient solution offers the experience of the du Pont specialists in agricultural engineering.

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Agricultural Engineering Digest

(Continued from page 246)

TESTS ON REINFORCED BRICK MASONRY COLUMNS, *M. O. Withey*. Amer. Soc. Testing Materials, Preprint 56 (1934), pp. 17, figs. 8. Tests of thirty-two 12.5-by-12.5-in brick columns 6 ft high made with Chicago common and with Waupaca face brick are reported. The variables included three percentages of longitudinal and a like variation in lateral reinforcement, together with two high-strength portland cement lime mortars. The results indicate that the column strength varies directly with the strength of the masonry and the percentage of longitudinal steel, and is increased by the use of lateral reinforcement. Strengths of 5,000 lb per square inch based on gross area and over 7,000 lb per square inch on the cores after shell spalling were attained. For suitable reinforced brick masonry columns a factor of safety of from 3.5 to 4.0 is suggested.

INTERNAL-COMBUSTION ENGINES, *R. L. Streeter* and *L. C. Lighty*. New York and London: McGraw-Hill Book Co., 1933, 4th ed. rev., pp. XIII + 539, figs. 327. This is a complete revision and fourth edition of this book relating to the theory, analysis, and design of internal-combustion engines. Those phases of thermodynamics which deal with the internal-combustion-engine process have been fully developed and are introduced wherever possible.

It is pointed out that the design of internal-combustion engines now includes such subjects as flame travel, flame-front areas, combustion-chamber design, synchronous vibrations, and heat flow. Design material is found throughout the book, the conventional design of the principal engine parts being presented in the latter part of the book. The section on design has been expanded in some places and rearranged in a more logical manner. This edition contains many references to recent researches and has drawn upon them for part of the presentation.

EMPLOYMENT BULLETIN

An employment service is conducted by the American Society of Agricultural Engineers for the special benefit of its members. Only society members in good standing are privileged to insert notices in the "Positions Wanted" section of this bulletin, and to apply for positions advertised in the "Positions Open" section. Non-members as well as members, seeking men to fill positions, for which members of the Society would be logical candidates, are privileged to insert notices in the "Positions Open" section and to be referred to persons listed in the "Position Wanted" section. Notices in both the "Positions Wanted" and "Positions Open" sections will be inserted for one month only and will thereafter be discontinued, unless additional insertions are requested.

POSITIONS WANTED

AGRICULTURAL ENGINEER, graduate in professional course, desires research and teaching position in state college. Prepared to teach a strong course in soil erosion control as well as other phases of land reclamation and farm power and machinery. Experience in research and educational work and administrative and field work. Now employed. Salary $3000. PW-263

POSITIONS OPEN

RESEARCH FELLOW in the field of farm structures wanted. Research work involved will be related in some definite way to the use of ceramic materials in the construction of farm buildings. The holder may take a full graduate program of work leading toward an advanced degree. Candidates must be graduates from a standard agricultural engineering curricula and, unless waived, must be in the upper one-fourth of their classes in scholarship. The stipend is $450 for nine months. PO-103

RESEARCH FELLOW in the field of mechanical farm equipment wanted. The conditions and stipend are the same as above (PO-103), except that the research work will be related to mechanical farm equipment. PO-104

INSTRUCTOR IN AGRICULTURAL ENGINEERING. Instructorship is in the field of mechanical farm equipment, but the holder will be expected to assist with shop instruction. A candidate looking forward to making educational work a life career will be given special consideration. Some graduate study will be permitted. The salary will be $1200 to $1500 for nine months. PO-105

AGRICULTURAL ENGINEERS competent to assume responsibility for gully control work, terracing, or other engineering work which may be necessary on sub-projects, are wanted on one of the Soil Erosion Service projects. Mature men are desired who are capable of supervising the work of camp engineers and also of younger engineers employed on the job. PO-106.